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ELECTROLYSIS BY TROLLEY CURRENTS.

In this issue we print the concluding section of Mr. W. Stuart-Smith's paper on the electrical condition of buried conductors due to leakage currents from street railways, which is probably the most important contribution yet made to the subject. The account of the distribution of current between the several systems of street railways is interesting, and shows that where there is more than one railway in the same territory any plan for the prevention of corrosion to piping cannot be confined to consideration of one road without reference to the other. The plan advocated by Mr. Smith to connect the rails to underground piping and employ the piping system as part of the underground circuit will not, we believe, meet with the approval of many, and we fear that the saving in copper entailed by such a method would have little weight in inducing gas and water companies to accord the necessary permission. An auxiliary system of conductors will, of course, be expensive, but its adoption is much more rational than the employment of underground piping, particularly as electrolysis at the joints of the piping would undoubtedly cause trouble eventually.

THE NEW TELEPHONE COMPANY.

The announcement last week of the plans of the Standard Telephone Company created an old-time sensation, which was accentuated through the public being entirely unprepared, owing to the secrecy with which the organization of the company had been carried on. It is true that rumors had been afloat for some time to the effect that a rival to the American Bell would soon be in the field, but so well had those interested kept their own counsel that no verification could be obtained. The fact is that the original intention of the organizers was to delay the announcement until June, by which time it was expected all plans would be completed for active work. This arrangement, however, was thwarted by the indiscretion of a Western member. The statements furnished by the officers of the new company bear out from their vagueness, the assertion in regard to the incompleteness of details at the present time, for beyond a list of those interested, the price at which telephone service is to be supplied, and the capitalization, but little definite information is given. Stress is laid upon the possession of valuable patents, but how much there will prove to be in these claims will remain for the future to determine. The statement in regard to patents on telephones, to the effect that there are now in existence only five commercially practicable instruments, of which the Bell Company controls the patents of two, and the Standard Company the remaining three, will come as a surprise to many, and more explicit details will be awaited with interest. As to the effect on the many smaller companies which have recently entered the telephone business, nothing can be predicted from the very indefinite outline of the policy thus far made public. Should this be based, as we hope it may be, on a "live and let live" policy, the effect will, we believe, be good, if for no other reason than that the telephone patent situation will be thoroughly cleared up. This is on the assumption that the Standard Company will bring to trial the monopoly claimed by the Bell Company of switchboard devices, in regard to which there is now so much uncertainty, and that would be likely to continue in the absence of a powerful interest to bear the great expense of the litigation necessary to establish the status of the many hundreds of patents now owned by the latter company. The public in any event will be benefited, provided that a combination is not made between the new company and the Bell Company, and a statement in a newspaper to the effect that such a combination was likely to occur was emphatically repudiated by the officials of the former when brought to their attention. The list, printed elsewhere in this issue, of those interested, containing as it does

the names of well-known capitalists and public men from every part of the country, gives assurance, we believe, that the organization was effected in good faith for the purpose of bona fide work and not with an ulterior object in view. While such an imposing array of names and a capitalization of such startling proportions may have the desired effect on the general public for the present, the electrical public will, however, await further particulars bearing on the technical features of the system before a similar interest can be expected from that direction. As it is understood that the telephone patents of Perrin, Bonta and Cole will be used by the Standard Company, we give an account of these elsewhere. We may add that in the absence of any explicit statement that the claims of the company as to the value of its patents rest upon those we describe, these latter cannot, of course, be accepted as by any means a full or complete statement of this part of the company's resources.

MASSACHUSETTS CENTRAL STATIONS AND STREET RAILWAYS.

The recent annual reports of the two bodies of State Commissioners of Massassuchetts having cognizance, respectively, of central stations and street railways show a state of affairs with respect to these two industries that cannot be considered especially satisfactory. From the resumés of the reports printed elsewhere in this issue, it will be seen that while the larger companies with few exceptions are paying satisfactory dividends, the smaller concerns still remain unprofitable. Of 59 electric stations, 35 paid no dividends, and only 19 paid 6 per cent. or over. We print elsewhere in tabulated form data of fifteen of the largest stations, part of which were taken directly from the returns and the remainder compiled from information there given. While the cost of the various parts of the plant are very suggestive, the other items have little professional value on account of lack of information in regard to the total output, and from the aggregation of all expenditures under the head of "operating expenses," which even includes insurance and taxes, the items given in the table relating to the latter having been taken from another source than the station reports. It should here be stated that the maximum dynamo capacity given does not always accord with the boiler and engine capacity, the variations in some cases being very wide. But few of the companies appear to be making provision for the future by laying up a depreciation fund; some of the larger companies have such a fund, to which additions are made annually, but in other cases where there is a depreciation item it appears that it was expended during the year, and probably should have been charged off to current repairs instead of being placed under the head of depreciation. The general neglect of the importance of this factor does not augur well for the future, particularly in view of the probability that the next few years will require a radical change of the equipment of many of the stations to place them upon a modern basis. To engineers it is a matter of regret that the returns of the stations are not made in such a form as to give them a greater value. We undertand that the Electric Light Commissioners are now authorized to demand returns of the output, and if, in addition, the operating and other expenses were required to be reported and itemized under appropriate heads, a great service would be rendered to those connected with electrical engineering. While this might not be a sufficient argument to bring about such an improvement, a stronger one presents itself in the benefit that would be derived by the station managers themselves through the means thus offered for comparison. As electric light supply is not a competitive business, the usual argument against publicity giving rivals an advantage cannot be urged. We cannot see that any reasonable objection can be advanced against the publication of returns somewhat after the classification of the English Board of Trade, and we believe that it would result in great improvements in the operation of the stations. From the report on street railways we learn that there was an increase of 113 miles of electric railway during the year ending September 30, 1894, and that there were only 103 miles of horse railway remaining in operation at that date. While this showing is gratifying, there is another side presented not so pleasing, in the information that but 30 of the 68 railways paid dividends. As in the case of central stations, but few of the street railway companies make provision for a depreciation fund, though the necessity is greater in the latter case. The report also refers to the evils of over-capitalization, which is a further disadvantage with respect to central stations. In conclusion, it may be said that the unfavorable features of the reports to which we have referred are to be largely ascribed to installation of plants without sufficient regard to suitability of conditions and economy of working, united in the case of street railways, to financial irregularities wtih respect to over-capitalization. While the results where unsatisfactory may reflect unfavorably upon electric lighting and street railways, the advantages of these are only temporarily obscured, and by the eventual reorganization on a rational basis of the unsuccessful companies, will finally be demonstrated in even apparently hopeless cases.

SELF-INDUCTANCE.

While most of our readers doubtless find no difficulty in grasping the significance of self-inductance or the coefficient of self-induction as measured in henrys, yet from inquiries received we learn that among others a difficulty does exist, and what follows is intended more particularly for the latter. Starting with the conception of the generation of E. M. F. by lines of force cutting conductors, it follows that if the current maintaining lines of force in, for instance, a coil, ceases, these lines will pass out of the coil, and in doing so will, in effect, cut the coil, thus generating an E. M. F., proportionate to the rate at which they are decreasing. In starting a current, lines are being introduced into the coil, in effect cutting it, so that in this case also an E. M. F. will be generated, but opposite to the former one and opposing the impressed E. M. F. These are called inductive E. M. Fs. and as their value depends upon the number of lines cut, it therefore follows, leaving aside the rate of cutting, that they also depend in a given circuit upon the number of coils and upon the number of lines present with a given current, which latter may be calculated for that current, directly if no magnetic material is present, or indirectly otherwise. As different circuits may thus have different inductive E. M. Fs. with the same current though the rate of cutting is the same, it is useful to separate the factor which gives rise to this difference. This can be done, for example, by assuming that in a circuit in which this factor is unity, a current of one ampere in dying out in one second at a uniform rate generates an inductive E. M. F. of one volt. This assumption, in fact, corresponds to that adopted, the factor referred to being called self-inductance, and the name of henry given to its unit value. Suppose, now, we wish to know the self-inductance of a shunt dynamo field having 4,000 turns in its coils, through which three amperes flow, the voltage of the machine being 100 volts at a known load. Knowing the various constants of the armature, the revolutions and mean magnetic leakage, the total number of lines of force or webers passing through the coils can be approximately calculated. We will assume these to be 3,000,000, but as our unit current is one ampere, 1,000,000 lines or webers will correspond to this, which, multiplied by the turns in the coil, give the entire number of lines that would cut one coil when the current changes in value from one ampere to zero. If the change were uniformly made and in one second, $4,000 \times 1,000,000$ C. G. S. units of E. M. F. would be generated, but as our henry refers to volts, this quantity must be divided by 10^8, which finally gives us 40 volts, or we have 40 henrys as the self-inductance of the field. As the leakage usually considered in a dynamo includes all lines which do not pass through the armature, but which, nevertheless, with respect to self inductance, cut some of the coils, the usual leakage coefficient must be decreased in calculating the total number of lines or webers in this connection. The above calculation assumes that the permeability of the iron of the field is constant, which, of course, is not the case. Properly speaking, in a circuit with iron the self-inductance as above defined is not a constant, but varies with every change of permeability. Where the exciting current is alternating, as in the field of a polyphase motor, if the total flux or webers corresponds to the maximum value of the current, the self inductance calculated must be divided by $\sqrt{2}$ in order to reduce to henrys, but in this case also the result is not theoretically in accordance with the definition.

The Standard Telephone Company.

For a year or more it has been whispered that a rival to the American Bell Telephone Company was in process of formation, but those interested so carefully concealed their plans that no facts for publication could be ascertained. As an instance of the secrecy maintained, when a representative of the company was negotiating recently for quarters in the Postal Telegraph Building, no intimation of the business of the prospective tenant could be obtained by the agent of the building, and the lease was executed on the strength of personal assurances from the well-known gentlemen whose names were given as references. The indiscretion, however, of a sanguine Westerner interested in the new enterprise led to a premature announcement last week, it having been the intention to delay publicity until June, by which time it was expected all plans would be perfected.

The offices of the company, which have been in the Morris Building, 68 Broad street, are now being removed to the Postal Telegraph Building, 253 Broadway, where a suite of rooms will be occupied on the tenth floor. Whether this means that an alliance is expected with the Postal Telegraph Company is not known, but the president of the Standard Company has intimated that some arrangement is contemplated for long distance service with one of the present telegraph companies.

The officers and the directors of the company are as follows: Thurlow Weed Barnes, president; John A. Brill, president of the J. G. Brill Company, car builders, of Philadelphia; Carl P. Boker, of the hardware, steel and iron house of H. Boker & Co., of New York; John W. Candler, formerly representative, railway president and merchant, of Boston; George Crocker, of San Francisco; Henry Merz, president of the Heller Merz Company, manufacturers of colors, of New York; Allen T. Nye, general manager of the company; Manning C. Palmer, president of the Syracuse National Bank and Electric Light Company, of Syracuse; Felix Rakeman, of Bulch & Rakeman, of Boston; Charles T. Strauss, of Charles T. Strauss & Bros., importers of lace, of New York; Louis Windmuller, of Windmuller & Roelker, of New York, and Senator John P. Jones.

The State companies which have already been formed to operate as licensees of the parent company are the New York Standard Telephone Company, capital $10,000,000, to operate in the State of New York; Eastern Standard Telephone Company, Boston, capital $6,000,000, to operate throughout New England; New Jersey Standard Telephone Company, capital $3,000,000, Jersey City, to operate in New Jersey and Delaware; Pennsylvania Standard Telephone Company, Philadelphia, capital $5,000,000, to operate in Pennsylvania; Columbia Standard Telephone Company, Washington, D. C., Baltimore and Richmond, capital $4,000,000, to operate in Maryland, District of Columbia, Virginia and West Virginia; Ohio & Indiana Standard Telephone Company, Cleveland, Cincinnati and Indianapolis, to operate in Ohio and Indiana; Michigan Standard Telephone Company, Detroit, capital $4,000,000, to operate in Michigan; Northwestern Standard Telephone Company, Chicago, Davenport and Milwaukee, capital $6,000,000, to operate in Illinois, Iowa and Wisconsin; Northern Standard Telephone Company, St. Paul, Minneapolis and Pierre, capital $4,000,000, to operate in Minnesota, North and South Dakota. The Central Standard Company, St. Louis, Kansas City and Lincoln, capital $5,000,000, to operate in Missouri, Kansas, Nebraska and Arkansas, is in process of organization, the promoter being Griffith Coit, president of the Union Trust Company, of St. Louis. The organization of the Mountain Standard Telephone Company in Denver, Albuquerque and Salt Lake City, capital $4,000,000, to operate in Colorado, New Mexico, Utah and Arizona, is in the hands of George Q. Cannon, the head of the Mormon Church. There are other companies being organized west of the Mississippi.

The president of the company in New England is John W. Candler, of Boston. Col. A. K. Conger, president of the Glass Trust, of Akron, Ohio, is president of the Ohio-Indiana company; Ex-Gov. Fairbanks, of Vermont, and George W. Hunt, of Portland, Me., represent that portion of New England; Pabst, the brewer, of Milwaukee, represents Wisconsin. John de Laitre and C. A. Pillsbury, the flour man, are connected with the company in Minneapolis, and the board is also organized for St. Paul. George Q. Cannon, of the Mormon Church, leads the list of the directors for Utah. The head of the organization in St. Louis is George A. Madill, president of the Union Trust Company. The president of the local company in Philadelphia is Richard W. Clary, president of the Solicitors' Loan & Trust Company, and C. W. Bergner, the brewer, and H. A. Berwind, the large coal operator, are members of the Pennsylvania board. Gen. Felix Agnus, owner of the Baltimore *American*, is in the Maryland board. The president of the company in Washington is Lemon G. Hine, who made a large fortune through his connection with the Mergenthaler linotype machine. James S. Clarkson will manage Iowa and the Northwest. W. J. Campbell, of Illinois, is said to represent Standard Oil interests, and John S. Runnells is credited to Pullman interests.

New York will be managed by Charles T. Armstrong, sugar importer; Lowell M. Palmer, president of the Brooklyn Cooperage Company; William Dick, sugar importer, New York; John Dunn, Jr., president of the Syracuse National Bank; Alva W. Palmer, clothing, of Syracuse; Gustavus E. Strauss, lace importer, of New York; Anthony N. Brady, of Albany; Henry Siebert, Gustavus E. Jahn, sugar importer; Henry D. McCord, flour and grain, and George Hutchins, of New York.

It is the intention of the company to supply a telephone service at the rate of $24 a year for dwellings and $36 for business places.

No difficulty is expected by President Barnes in establishing an exchange in New York by reason of the connection of the Metropolitan Telephone Company with the subway company; he states that the subways are open to all upon payment of rental at the rate of $800 per mile for a cable of 700 wires.

Marcellus Bailey, who drew the specifications for the original Bell patent, is one of the company's legal advisers.

The statements made by the Standard company as to the patents under which it will operate are very vague and are to the effect that the instruments to be used are proof against the effects of induction, and are among the "only five known efficient telephones, two owned by the Bell company and the other three owned outright or controlled by the Standard." "All other 'phones are infringements on these patents" it is added. We have learned however, that the principal patents of the Standard Company are a number granted from 1885 to 1888 to G. W. Cole, of Detroit; J. W. Bonta, of Philadelphia, and T. J. Perrin, of Brooklyn, and of these we give an illustrated description elsewhere in this issue.

General Electric and Westinghouse.

As we go to press no official announcement has been made in regard to the terms of the General Electric and Westinghouse arrangement as to patents, but it is probable that a statement will soon be made public. One of the financial agencies ascribes the delay to the General Electric Company, the reason offered being the desire of some of those connected with that interest to take advantage of the situation with respect to the stock market. It is reported that the executive committees of the two companies have approved the plan of pooling the patents, which now awaits the signature of one member of the committee, T. Jefferson Coolidge, Jr., who has been detained in Boston on family business. By the terms of the plan it is said that each company will contribute an equal percentage to the pool to defend the patents of the two concerns against outside litigation and competition.

Street Railways in Massachusetts.

The annual report of the Massachusetts Railroad Commissioners gives the total mileage of street railways in that State on September 30, 1894, as 928, an increase of 54 miles over the preceding year. Of this total 824 miles were operated, in whole or in part, by electricity, and 103 miles wholly by horse power. This shows, as compared with the previous year, an increase of 113 miles equipped with electric power and a decrease of 59 miles equipped for horse power only. There were on the same date 59 miles of electric railway in course of construction. All of the lines use the overhead trolley except the Milford & Hopedale road, which used the storage battery when in operation. The largest roads are the West End, of Boston, and the Lynn & Boston, with 196 and 135 miles of track respectively.

The total income above operating expenses from all sources was $3,507,369—an increase of $114,510 over the previous year; the fixed and other charges on this income balance on account of interest, taxes and rentals amounted to $1,694,701—an increase of $295,241; leaving as the net income available for dividends the sum of $1,812,668—which was less by $180,731 than the corresponding sum for 1893.

The ratio of operating expenses to gross income was 69.51 per cent., the net earnings $3.65 per mile owned, and the expense of running and net earning 21.05 and 9.23 cents per car mile run.

The average cost of the street railways of the State per track mile

(including the cost but not including the length of sidings), as it stood on the books of the companies September 30, 1894, was $26,748.31 for construction, $11,527.81 for equipment, and $15,356.08 for land, buildings and other permanent property—making a total average cost of $53,632.20 for each mile of main track, including second track.

These figures, says the report, are of value as showing how heavily the street railways as a whole are capitalized, or, in other words, the average amount per mile on which dividends and interest are to be earned. They furnish very little clue, however, to the cost per mile of any particular railway which, as returned by the several companies, ranges from $11,152 to $97,993 per mile.

The report states that the financial condition of the companies as a whole, though but little changed from the previous year, was changed for the better. The aggregate surplus, which had been reduced from 15 almost to 2 per cent. in the preceding seven years, was slightly increased the last year. This result was secured, however, by a reduction in the amount and rate of dividends declared. The amount of dividends declared was less by about $106,000 than in 1893. But 30 out of the 68 companies paid a dividend. The average rate on the capital of the paying companies was 7 per cent. as against 8.22 per cent. the previous year.

The floating debt was reduced about $2,750,000; but this was by the issue of stock and bonds, and not by payment from surplus earnings.

The ratio of operating expenses to gross earnings from operation, which had shown the remarkable decrease of nearly 12 per cent. since the introduction of electric power, the last year made a slight increase.

ger and per car mile and round trip run, the net earnings per total mile of railway owned have increased only 50.87 per cent, while the cost of railway per mile has increased 59.17 per scent., and the capitalization per mile 63.95 per cent.

Annual Report of the Massachusetts Board of Gas and Electric Light Commissioners.

The annual report of the Massachusetts Board of Gas and Electric Light Commissioners shows that five companies supplying electricity have been incorporated during the last year, at Palmer, Reading, Lenox, Grafton and Attleborough, of which only the Central Massachusetts Electric Company at Palmer has commenced operations. The mortgage on the North Attleborough Steam & Electric Company's plant was foreclosed during the year and the property passed into the hands of the Attleborough Steam & Electric Company. The Woburn Electric Light Company has passed into the hands of a receiver and foreclosure proceedings have been commenced against the North Shore Electric Company. During the year the plant of the Nantucket Electric Light Company was taken possession of by the bondholders, in whose interest it is now being operated.

As to municipal ownership, the towns of Arlington and Hull are the only municipalities which have acted upon this matter for the first time during the year, and the latter town has acquired the plant of the private company within its territory. The following towns have plants now in operation: Braintree, Danvers, Hingham, Hull, Middleborough, Needham, North Attleborough, Peabody, Wakefield, and Wellesley. Of these, Middleborough and Wakefield have the only plants for supplying both gas and electric light. The

	Boston Electric Light Co.	Boston Edison Elec. Ill. Co.	Brockton Edison Elec. Ill. Co.	Cambridge.	Fall River Electric Light Co.	Fall River Edison Elec. Ill. Co.	Haverhill Electric Co.	Lowell Electric Light Corporation.	Malden Electric Co.	Pittsfield Electric Co.	Salem Electric Lighting Co.	Somerville Electric Light Co.	Boston Suburban L. & P. Co.	Springfield United Elec. Light Co.	Worcester Electric Light Co.
Assessed valuation	$710,900	$1,208,800	$91,250	$254,000	$120,000	$90,600	$87,950	$201,380	$140,000	$100 000	$195,000	$118.500	$88 600	$321,600	$253.300
Plant investment, total	$1,419,336	$2,949,571	$239.494	$441,124	$184.801	$130,520	$234,187	$485,733	$349,859	$178,685	$239.000	$316,544	$250,925	$557,880	$298,159
Real estate	$532,379	$717,198	$52.720	$74 056	$31,000	$30,000	$48,591	$27,239	$27,527	$40,964	$45.000	$22,739	$12,086	$104.453	$75,000
Steam plant	$436,594	$638,555	$36.806	$95 044	$41,538	$24,300	$50,965	$98,051	$45,430	$36,656	$85,000	$47,934		$134,755	$54,730
Electric plant	$449,593	$240.000	$80,568	$152,052	$49,650	$17,250	$58,405	$119,640	$68,539	$52,429	$28 000	$64,597	$238,835	$171,143	$79 000
Distribution	$951.770	$1,353,818	$69.400	†$119,972	$62,613	$58.970	$76,226	$240,803	$208,363	$48,636	$96.000	$181,274		$147,529	$89,429
Maximum dynamo capacity, total in kw.	3328	4608	578	622	339	475	367	796	526	369	524	550	493	814	882
Incandescent, kilowatts	1151	4608	475	312	39	475	240	316	444	312	344	368	345	519	399
Arc, kilowatts	2177	—	103	210	300	—	127	480	82	57	180	182	148	295	483
Income	$540,967	$587.514	$59,574	$103,471	$75,967	$51.114	$38,137	$118.574	$85,723	$49 320	$96,392	$71,686	$65,335	$171,346	$136.736
Operating expenses	$376,005	$317,470	$42,022	$64,761	$43,985	$30,147	$27,468	$73.080	$49.658	$35.602	$63,313	$53.558	$59.355	$95.592	$73.724
Percentage of income	69	54	70	62	58	59	72	62	58	71	66	74	90	44	54
Dividends for 1894, per cent	8	8½	6	6	6	8	3	7	8	5	6	6	—	6	8
Depreciation	$300	$17,747	$3,036	*$10,000	$13,500	$10,112	—	$3,823	$20,000	$5,000	$30,639	—	—	$37,658	$41.200
Taxes	$21.036	$26.854	$1,920	$4.191	$1,992	$1.613	$2,035	$4,491	$2,202	$1,640	$3,496	$2.532	$762	$5,155	$3,925
Steam plant, investment per kw.	$131	138	63	153	123	51	139	123	86	99	162	87		165	62
Electric " " "	$135	52	139	244	147	36	160	150	130	142	53	117	484	210	89
Distribution, " "	$283	293	120	192	183	124	208	302	396	132	183	329		180	101

*Reserve fund. †Construction account $13,195 additional.

There have been the last year no visible instances of inflation or stock watering; and, so far as appears, no further absorption of the control of domestic companies by foreign corporations or syndicates.

During the two preceding years the average cost and capitalization per mile of railway, as returned by the companies, had increased at the rate of over $6,000 per mile a year. A considerable increase was in many cases entirely legitimate, as representing the higher cost of new electric railway, or the additional cost of equipping with electric power original horse lines. In other cases the increase was largely the result of stock watering, pure and simple. The last year, on the contrary, there was an actual reduction in the average cost and capitalization per mile of railway as it stood on the books of the companies; and, although the reduction was small (about $400 per mile), it indicates a radical change in the right direction.

The necessity to the financial success of the electric system of keeping the cost and capitalization per mile of railway within the lowest practicable limits was remarked in the last annual report, and a table is printed comparing the net earnings per mile of railway and the cost of railway per mile in 1893, with those of 1888—the last year in which the railways were operated wholly by horse power.

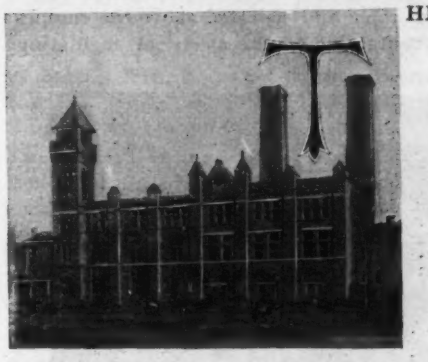
Notwithstanding the large gain in net earnings per single passen-

others manufacture only electric light. The towns of Danvers, Needham and Wellesley do no commercial business, and the two last named purchase their electricity from a private company. The reports show that 40 towns have thus far taken official cognizance of the subject of municipal ownership, but in most cases no action resulted.

There were 81 companies in active operation on June 30, 1894, supplying electricity, of which 59 had only electric plants. Of the electric companies, 35 paid no dividends, two paid 2½ and 3 per cent., respectively; three paid 5 per cent., eleven paid 6 per cent., two paid 7 per cent., four paid 8 per cent. and two paid 8½ per cent. The larger companies in general paid dividends.

Above we show in tabulated form some of the data relating to the largest companies. In the report the maximum dynamo capacities are given in 16-cp, 1,200-cp and 2,000-cp lamps, and in the table are expressed in kilowatts on the assumption of 60 watts, 333 watts and 500 watts of supply, respectively, for the lamps named. The percentage of income and the investment per kilowatt in the steam and electric plants and distributing system, respectively, have been calculated from the appropriate data. It should be noted that in but few cases is there any provision for a depreciation fund, properly speaking, the amounts charged off for depreciation frequently being expended during the year and rarely carried in a fund for future expenditures for renewals.

A Modern Electric Light Station.



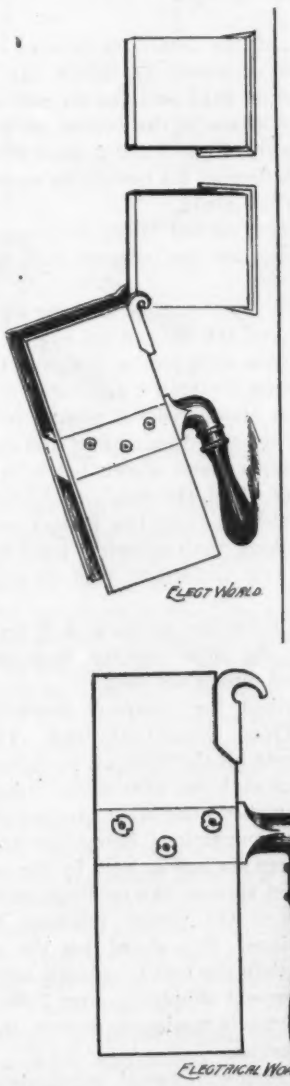
HERE is perhaps nowhere to be found a better example of modern central station design and construction than is afforded by the First District Station of the Edison Electric Illuminating Company, of Brooklyn, located in Pearl street, near Willoughby, which, though not yet quite through the process of changing over to latest methods, nevertheless serves to forcibly illustrate the strides made in the design of electric light and power machinery within a comparatively short period.

Within a floor space of 1,800 square feet are engines and generators capable of supplying 48,000 incandescent lamps, together with two sets of "boosters." There are two vertical engines, each direct connected to two 200 kw multipolar generators, as shown in Fig. 4, and two vertical engines each direct connected to two 400-kw multipolar generators, a partial view of one of which is given in Fig. 6. The smaller engines are 750 hp, three cylinder, compounds, made by the Lake Erie Engineering Works, and the larger ones are Williams 1,500-hp compounds, made by William Todd & Company. The generators are direct current, twelve pole machines, of the familiar General Electric type.

Near the engines and generators are two sets of Barstow boosters, each consisting of two small continuous current dynamos direct driven by a motor. Each dynamo has a current capacity equal to the load carried by the feeder on which it is to work, but the E. M. F. generated is comparatively low. Fig. 7 shows one set of "boosters." The operation is as follows: Supposing the E. M. F. at the end of one of the feeders supplied by a given generator to be considerably lower, from any cause, than that of the other feeders supplied from the same source, it is manifestly impracticable to make the voltages equal by any regulation of the generator. The

FIG. 3.—PARTIAL VIEW OF SWITCHBOARD.

"booster" set is put in operation, the motor, of course, being driven from the regular mains, and the *armature* of the "booster" dynamo is thrown in series with the feeder whose voltage is to be raised, while the field winding is connected across the station mains in series with a rheostat. The E. M. F. furnished by the "booster" dynamo is thus added to that of the regular generator so that the voltage at the end of the low feeder is brought up to and maintained at the proper point, without affecting the voltage of the other



FIGS. 1 AND 2.—SWITCH DETAILS.

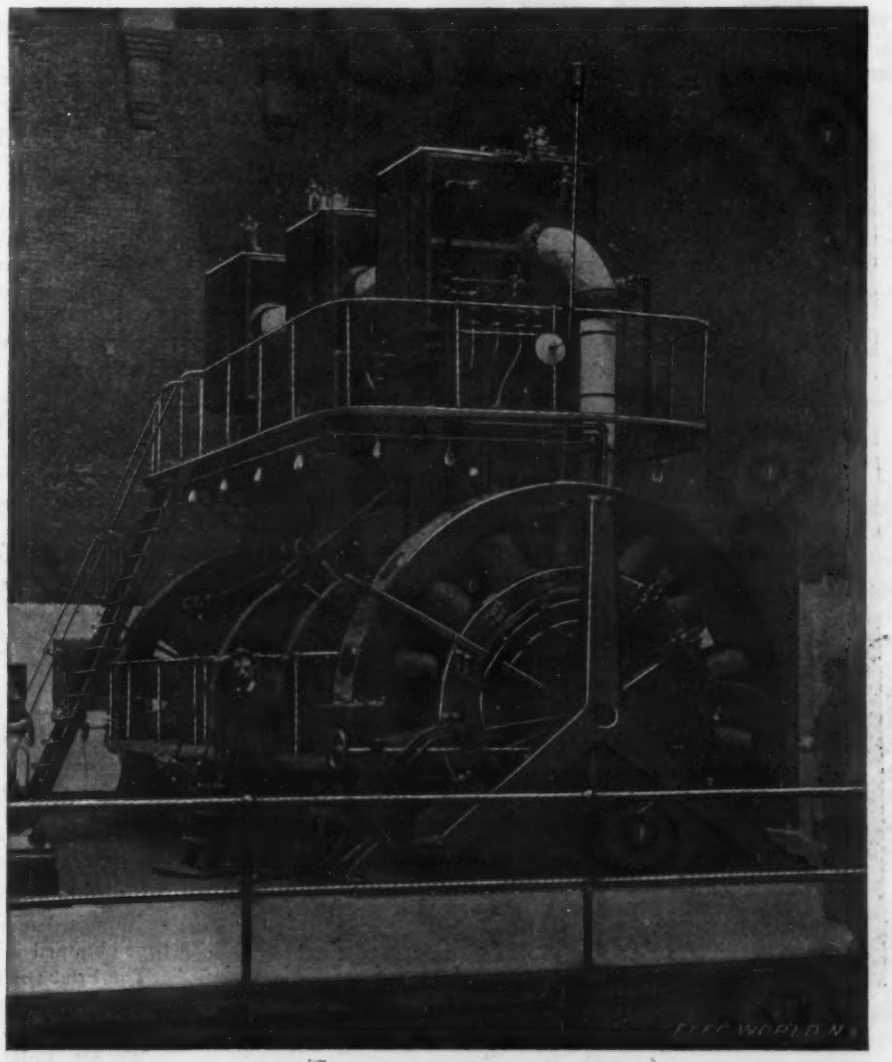


FIG. 4.—750-HP AND 200-KW GENERATORS.

feeders. The system is also used to cut down the voltage of a feeder in the event that the E. M. F. at its far end exceeds that of the other feeders supplied from the same bus bar. In such a case the armature of the auxiliary dynamo is, of course, so connected in with the "high" feeder as to *oppose* the E. M. F. furnished by the main generator, thus acting as a "choker" instead of a "booster."

In the Barstow "booster" system here referred to there are two auxiliary dynamos because the three-wire system of wiring is used throughout the plant. The space occupied by the dynamos and engines is free from pillars, braces, etc., and a 15-ton traveling crane is provided overhead which travels over the entire dynamo room. This crane is electrically operated, of course.

FIG. 5.—SIGNALING APPARATUS.

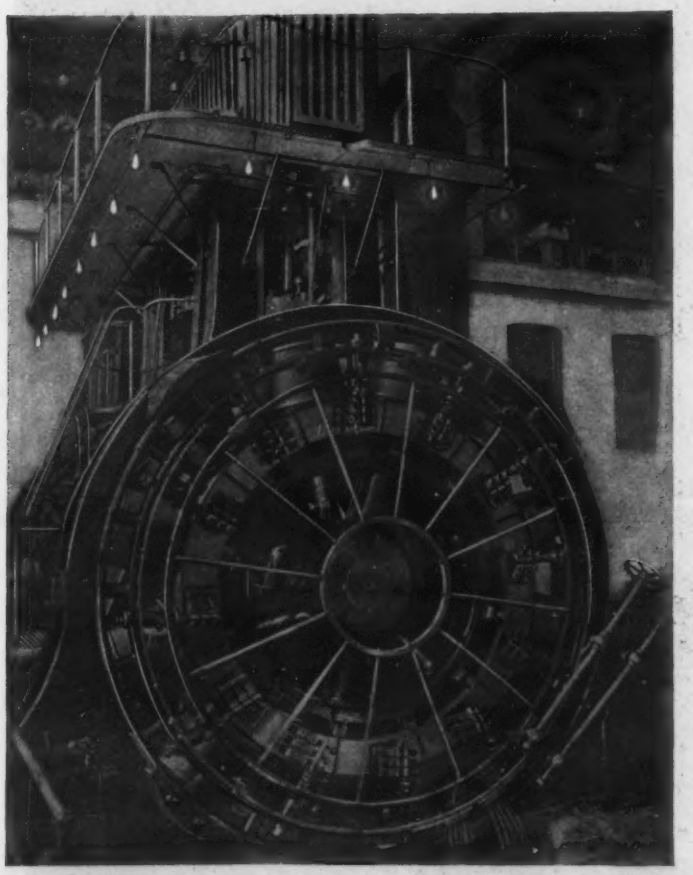


FIG. 6.—400-KW DIRECT CONNECTED GENERATOR.

The dynamo room will eventually contain two 750-hp engines with two 200-kw generators each and four 1,500-hp engines, with two 400-kw generators each, in addition to the present equipment.

At one side of the dynamo room and elevated above the engines is the switchboard gallery, containing all the electrical regulating apparatus. The central section of the board is devoted to volt meters, dynamo ammeters and connections, while the feeder ammeters and connections are put on flank sections on each side of the dynamo section. Fig. 3 gives a view of the central section and one of the end sections of the board. Figs. 1 and 2 show details of the switches used on the feeder sections of the board, the novel feature of which is the detachable switch-blade.

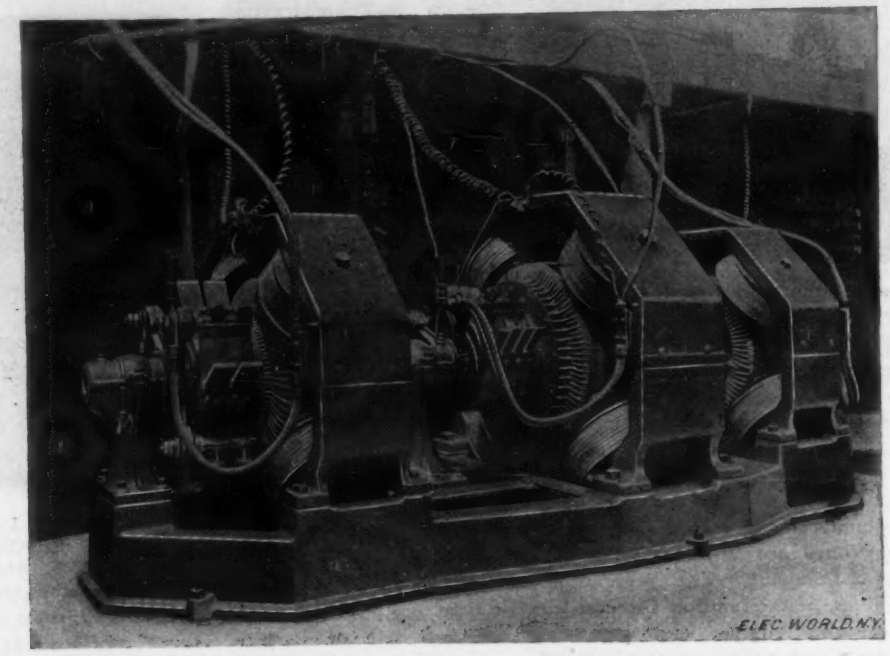


FIG. 7.—BOOSTER DYNAMOS AND MOTOR.

From the switchboard heavy cables are led down to a large vault beneath the sidewalk where connections are effected with the system of underground feeders.

A very convenient device, shown by Fig. 5, is used for signaling between the switchboard gallery and the floor of the engine room. On the face of the apparatus are painted figures to designate the different engines, and the words "Stop," "Half" and "Full," referring to the operation of the engine designated. A pointer indicates the number of the engine and a ring carried on a short arm encloses the desired signal word. The upper hand-wheel below the face operates the pointer and the lower wheel the ring-arm. There are two of these mechanisms exactly alike, one on the gallery and the other below on the engine room floor, the two being mechanically connected. A bell is provided to call the attention of the engineer to the signal dial.

The boiler plant consists of eight 240-hp Babcock & Wilcox and one 600-hp Morrin Climax boiler, the latter having been recently added. Three Davidson boiler feed pumps are used.

In addition to the station described the company operates two others, known as Second and Third District Stations. There is telegraphic communication between all the stations, an instrument being located at the switchboard of each so that when it becomes desirable to shut down one of the stations the other can be instantly notified to take the load, proper connections being provided for that purpose. The log of all three stations is kept by the switchboard attendant at the First District station, the readings and other information being telegraphed in at the proper intervals by the switchboard men at the other stations. It is stated that the service thus obtained is more satisfactory than the best telephonic service.

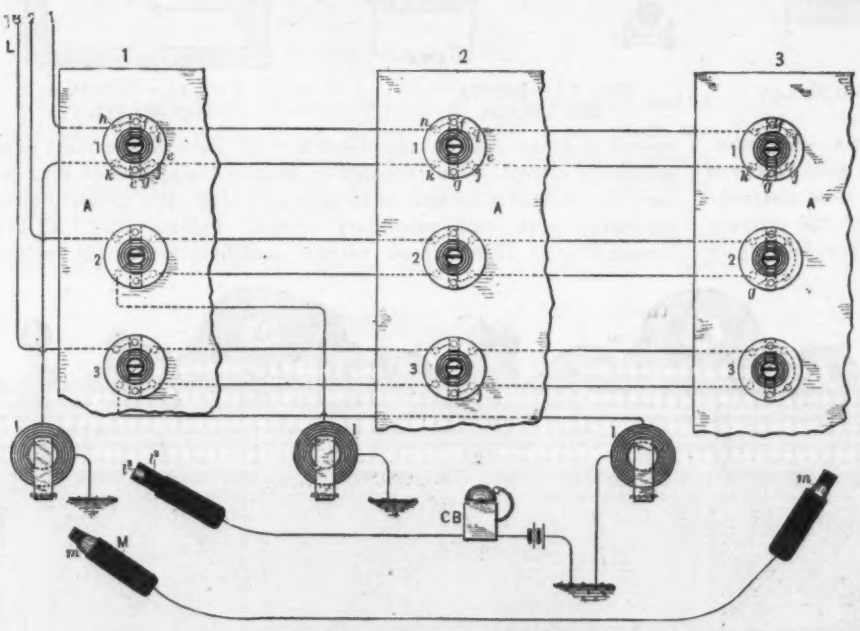
The First District station is at present supplying over 3,000 constant potential arc lamps and 2,000 hp in stationary motors, in addition to the regular incandescent service.

We are indebted to W. S. Barstow, general superintendent, for his courtesy in furnishing information, and to Mr. William Yaeger, superintendent of the generating department, for much kind assistance in procuring photographs of the building and apparatus.

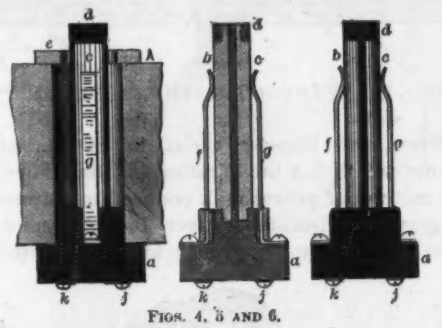
The Perrin, Bonta and Cole Telephone Patents.

The Perrin switchboard patents (Nos. 348,578 and 348,579) were granted Sept. 7, 1886, on applications filed Dec. 19, 1885. The Perrin switchboard is described at length in THE ELECTRICAL WORLD of Sept 4, 1886, from which we reproduce the accompanying illustrations. Three sections of the board are shown in Fig. 1, and Figs. 2 to 10 illustrate details. Each section as shown is provided with 100 annunciator drops and the usual number of "clearing out" annunciators, which are situated at the top of the board. The line terminal device is shown in Figs. 4, 5 and 6, and consist of a plug of insulating material *a*, carrying two metallic spindle sections *b*, *c* insulated from each other, and against which bear two contact springs *f*, *g*, projecting forward through the aperture in the board. Each spring and each spindle section are independently connected with a binding screw on the rear face of the plug, as shown in Fig. 7, Fig. 3 showing a plan view of the plug. Each opening of the board is, in addition, faced with a metallic ring, *e*, Fig. 4, shown in detail in Fig. 8. All of the main lines (Fig. 2) are brought in at section 1 of the board, and after running to their terminals of like number on the several sections, pass to their annunciators *I*, *I*, at their particular boards, and thence to earth.

Following out the course of line 1, section 1, it runs to the binding screw *h* at the bottom of the plug described above, which screw



FIGS. 2 AND 3.—LINE TERMINAL CONNECTIONS AND SWITCH PLUGS.



FIGS. 4, 5 AND 6.

FIGS. 7, 8 AND 9.

DETAILS OF LINE TERMINALS.

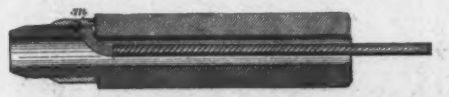


FIG. 10.—SWITCH PLUG.

insulating material on the interior of the sleeve breaks connection with the lower spring finger *g* and the lower spindle section *e*.

Having ascertained that the subscriber's line is not in use, the operator proceeds to make the desired connection with each of the connected plugs *M*, Fig. 3. These plugs, one of which is shown in section in Fig. 10, are provided with annular conducting rings *m* surrounding a tube of insulating material which passes over the spindle sections. The end of the tube of insulating material separates the fingers *f* and *g* from the upper and lower spindle sections, respectively, while the conducting ring makes contact with the face or terminal ring *e*. When these plugs are inserted the main line circuit of each subscriber will be completed through the upper spring finger *f*, ring *e*, conducting sleeve *m* on the plug, and thence to the subscriber's line. The circuit will now be open by the separation of the spring fingers from the spindle sections, so that the earth and annunciator of each subscriber will be disconnected. If, therefore, the line is in use, an operator at any of the boards upon testing that line will get no signal on his call bell. For instance, suppose line No. 1 is in use and has been connected on its particular section No. 1, and that the operator in No. 3 inserts the test plug at the terminal of that line on section No. 3, the test circuit would then be from the earth to battery and call bell to the conducting sleeve of the plug, spring finger *g*, and screw *j*, through the upper terminal on sections Nos. 2 and 3 to the screw *i* and upper spindle section at the terminal of section No. 1. But here, as has been seen, the circuit is open, because the connecting plug *m* has been thrust between the spindle section and spring finger *f*. There would, therefore, be no circuit for the operator's call bell. As shown before, also, there would be no circuit from the lower spindle section of terminal No. 1 on section No. 3, where the test plug had been inserted, because the insulation would break the circuit from the spring *g* to the lower spindle section, and there would, therefore, be no ground through the annunciator on line No. 1 at section No. 1.

is connected with the upper spring finger *f*. The latter in turn bears against the spindle section *b*, which is connected with the binding screw *i*. Thence the line continues to section 2, following out the same course, and then to section 3, the last section.

On the last board of the line, after passing as usual to the screw *i*, it is connected around the plug to the screw *j*. This screw is connected to the lower spring finger *g*, which bears against the lower spindle section *c*, and is, in turn, connected to the binding screw *k*. The line then passes back again to the corresponding plug of each section, passing through the lower spring fingers and spindle sections, being finally connected to its proper annunciator and then grounded.

A test plug, shown in the lower portion of Fig. 2, is used to ascertain, before making a connection, if the line is free, the metal sleeve being connected through a call bell and battery to earth, as shown. Owing to the peculiar construction of this plug, if inserted in a terminal the operator's bell will ring if the line is not in use, and the subscriber will be rung at the same time. For instance, assuming that the test plug has been inserted in the terminal of line No. 1 in section No. 2, the circuit of the main line No. 1 will run through the upper connection *h*, *f*, *i* of its terminal on section No. 1 as usual, and thence to its terminal on section No. 2. With the test plug inserted here, however, the circuit runs from the lower spring finger *g* through the metallic sleeve of the plug to the call bell *C*, *B* and battery to earth. This gives a ground at the subscriber's and at the central office, and rings the bell at both places. There will be no circuit to the annunciator of the line, because the

In the article from which the above is abstracted it is claimed that the operation of the board is very simple, and that it can be cheaply constructed. The patents include devices for the operation of the same board on metallic circuits.

In THE ELECTRICAL WORLD of Sept. 19 is described a telephone transmitter and relay patented by the same inventor on Aug. 18, 1885 (Nos. 324,726-7). Two other patents of the same date (Nos. 324,728-9) are for a telephone transmitting device and a telephone transmitter, respectively. As shown in Fig. 11, the transmitter and relay consists of a ring magnet *dD*, a diaphragm *C*, preferably of a non-magnetic metal, with an electrode *g*, carried by the diaphragm, and a pair of swinging arms, of magnetic material, *G*, carrying the other electrode; these arms rest on adjustable projections *K*, which are soft iron pole extensions from the ends of the ring magnet where it is split. Each of the electrodes *g* are included in a separate primary circuit of an induction coil (patented Aug. 19, 1884, No. 303,948, and Nov. 4, 1884, No. 307,728). These primaries are wound alternately with alternate layers of the same continuous secondary,

so that variations of resistance occurring between the two pairs of contacts g, g' will both act upon a continuous secondary line for telephonic transmission. The attraction of the pole pieces K upon the ends of the arm G maintains the electrodes g, g' in contact under magnetic tension, so that they will not separate when a loud sound is made. In a groove d of the magnet is wound a coil of the secondary, which intensifies the attraction of the pole pieces, and adapts the instrument for use as a telephonic relay or repeater. Currents sent over the main line from a distant station will thus traverse the secondary wire, causing variations in the attraction of

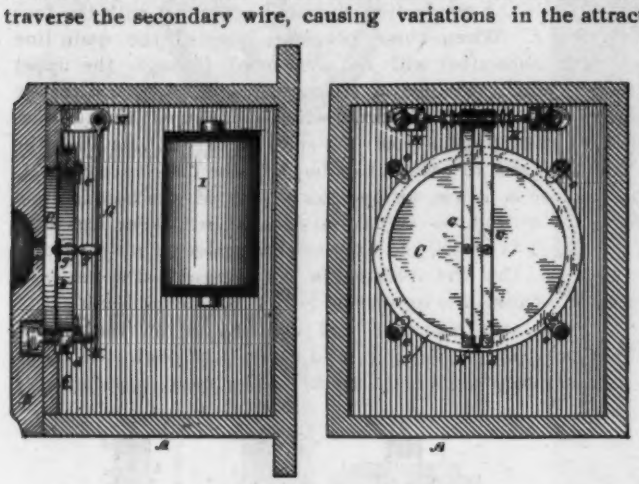


Fig. 11.—Perrin Telephone Transmitter and Relay.

he levers, and thereby variations of contact of the electrodes. Another patent is a modification of the above. The final patent is for a method of providing a connection between the loose electrode of a gravity transmitter contact and the conductor of the primary circuit in which it is placed, which will permit the free jostling or rotation of the electrode around its support without in any way impairing its connection with the circuit. The device consists of a carbon ring resting on a carbon disc secured to a pin from the centre of a horizontal telephone diaphragm. Secured to the annular carbon is an arm projecting radially on opposite sides, and with its outer ends turned down and dipping in a circular metallic trough. The telephonic current passes from the diaphragm to the lower carbon and from its upper face to the lower face of the carbon rin thence through the arms to the mercury and line.

There are 12 patents granted to J. W. Bonta, of Philadelphia, between the dates of Jan. 5, 1886, and Nov. 26, 1889. Fig. 12 illustrates a telephone on which a patent (No 333,816) was granted Jan. 5, 1886, the object of which was apparently to avoid the Bell principle, as the specification states that by means of it speech can be transmitted "in a commercially practical manner over a line which is alternately broken and closed by the transmitter, as in the Reis system." The cut clearly illustrates the principle of the invention. The single claim is for the art or method of transmitting articulate

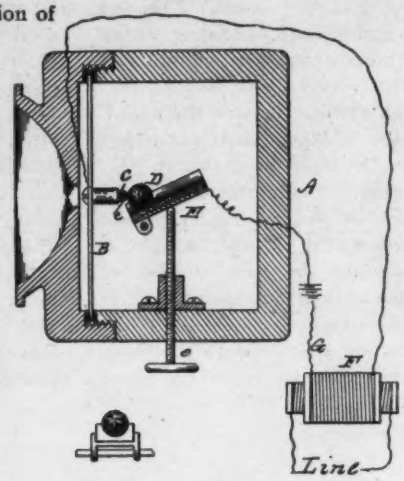


Fig. 12.—Bonta—
No. 333,816.

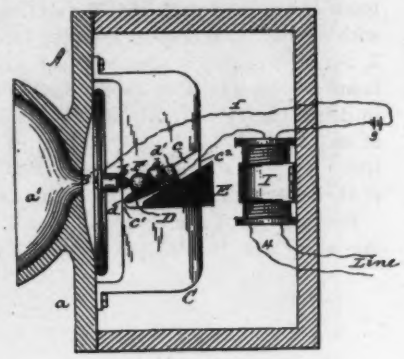


Fig. 13.—Bonta—
No. 364,475.

speech or other sounds telephonically by induced currents over a secondary circuit, which consists in causing the speech or sounds to vary the resistance as well as to open and close the primary circuit associated with such secondary circuit. Patents Nos. 322,176-9 (issued Nov. 9, 1886) are on various modifications of the inclined

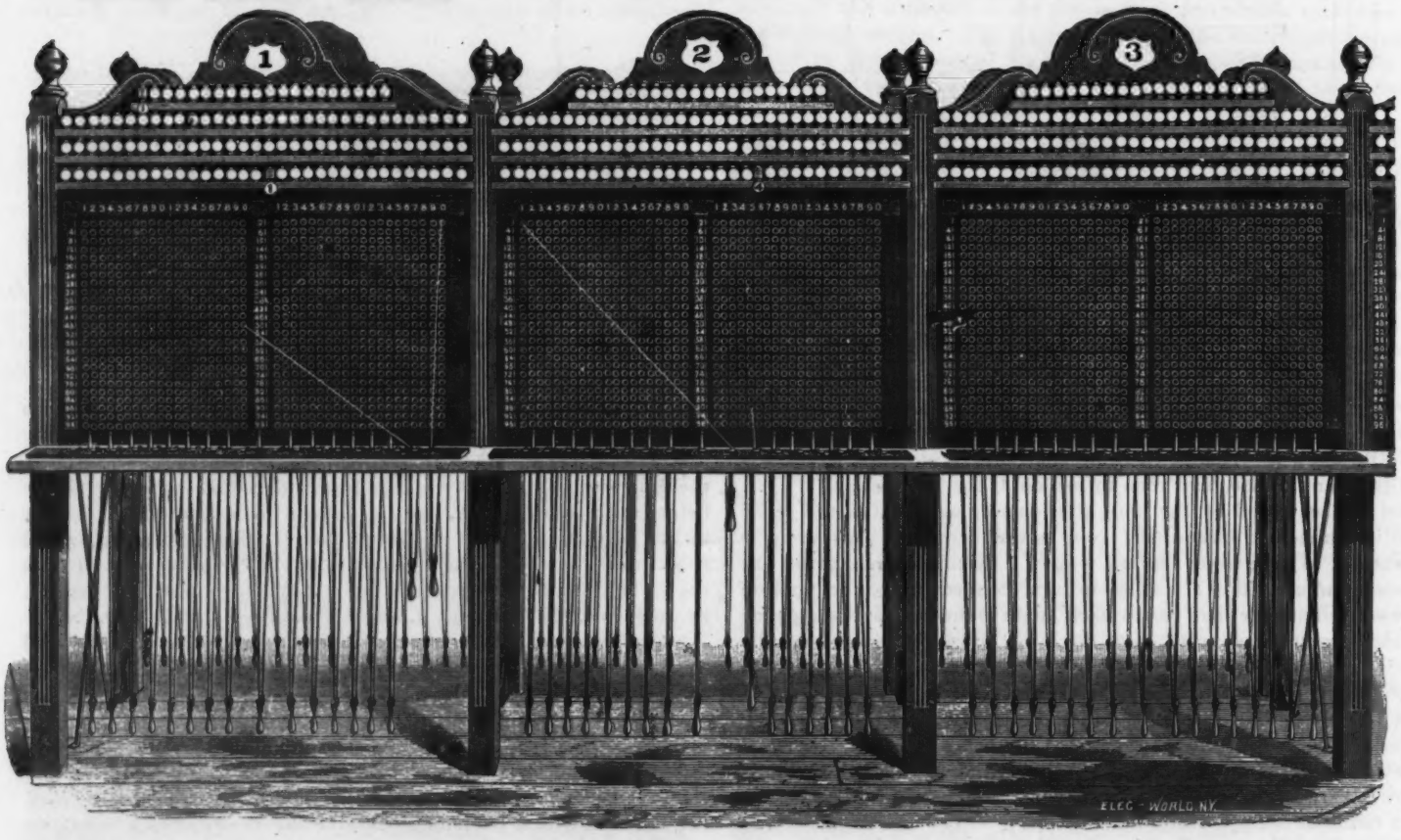


FIG. 1.—THE PERRIN MULTIPLE SWITCHBOARD FOR ONE THOUSAND SUBSCRIBERS.

platform or plate supporting the ball. Fig. 13 shows another modification, patented June 7, 1887 (No. 364,475), in which adjustment is secured by means of the sliding wedge E.

In a patent issued April 12, 1887 (No. 361,124), Bonta states that he has discovered that vocal and other sounds can be transmitted without the necessity of vibrating or moving a body capable of inductive action in the neighborhood of a "conductivity" wire, or

vibrating the conductivity wire itself in the neighborhood of a body capable of inductive action, or varying the resistance of the circuit, or varying the power of, or affecting, the battery in any way. Referring to Fig. 14, the patentee represents the phases of a pendu-

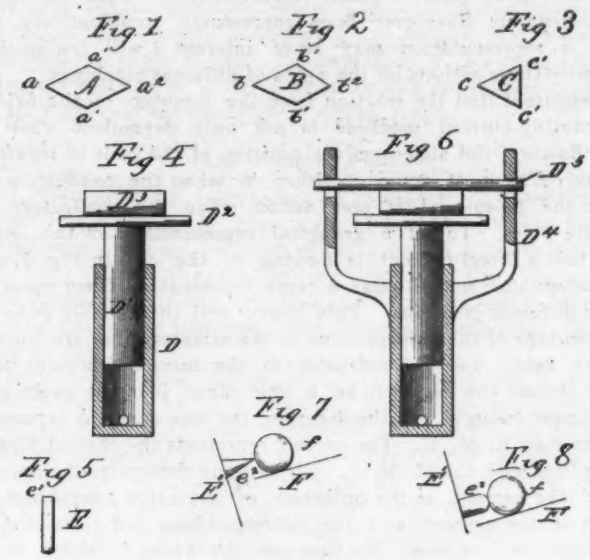


FIG. 14.—BONTA—NO. 361,124.

lum by Fig. 1, a being the starting point a', a' the vertical, and a^2 the final point; a diaphragm should have the same effect, but owing to it being held by its edges, Fig. 2 would similarly represent its action, and Fig. 3 the case where a spring or weight is used to offer resistance to the diaphragm.

Fig. 8 is to show that the pressure of D^3 on the platform of a hydraulic ram is not affected by the motion of the ram, which fact

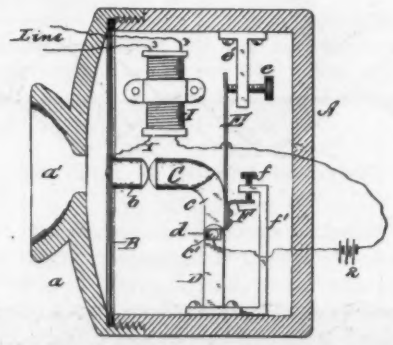


FIG. 14½.—BONTA—NO. 365 778.

the inventor says is diagrammatically represented by Fig. 5. Fig. 6 is the hydraulic ram with a spring D^5 above the weight, which case he says is represented by Fig. 3. After a lengthy discussion the patentee considers that Figs. 7 and 8 represent, telephonically, the conditions of Figs. 4 and 5, and that the rolling body and movable body (diaphragm) "move as one, no matter how the impelling force or power may be varied, and the contact pressure between the bodies, therefore, remains constant." The patentee claims that "if

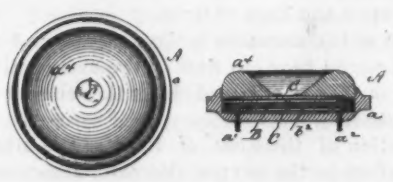


FIG. 15.—BONTA—NO. 415,700.

this law be utilized in the construction of telephones and the instrument transmitting vocal or other sounds, a method of transmitting vocal or other sounds other than by electrical undulations similar in form to the vibrations of the air accompanying said vocal or other sounds would be produced."

The claims for this patent are for "the art or method of transmitting vocal or other sounds telephonically by causing intermittent or pulsatory currents of a uniform volume or intensity, and of durations corresponding to the phases of the oscillations of the diaphragm;" or "causing electrical impulses of constant volume and of durations corresponding to the elements of the sound force or ways;" or "causing electrical impulses which differ in duration with the overtones and fundamentals of the vocal or other sounds." The instrument illustrated which applies the discovery claimed in this patent is that of Fig. 12.

Another form of transmitter was patented by the same inventor

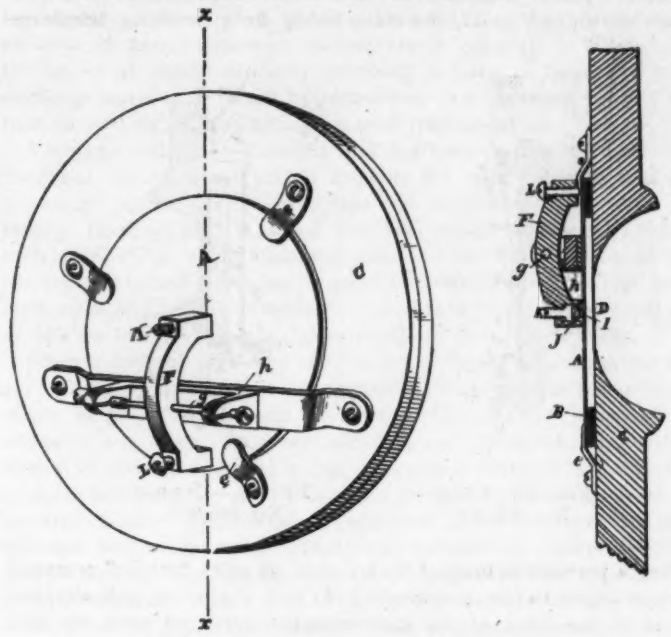


FIG. 16.—COLE—NO. 351,250.

on July 5, 1887 (No. 365,778), which, as shown in Fig. 14½, consists of an electrode C, attached to a right angled bar c pivoted below the electrode, and acted upon by the vertical spring E and the horizontal spring F, both springs having a common point of attachment to the arm C and adjustable tension devices. The diaphragm is either fixed or hinged, being of carbon in the latter case. The object of this invention is stated to be for maintaining efficient initial contact for the electrodes, and for varying their contact pressure.

On Sept. 26, 1889, a patent (No. 415,700) was issued to Bonta for a telephone receiver having "a magnet which admits of the use of a diaphragm which does not vibrate in front of the magnet in the sense that the diaphragm of the Bell type of receivers vibrates, and yet produces articulated sounds clearly, distinctly and loudly." The magnet is in the form of a circular disc having a coil wound on its periphery. The disc is slotted radially both from the periphery

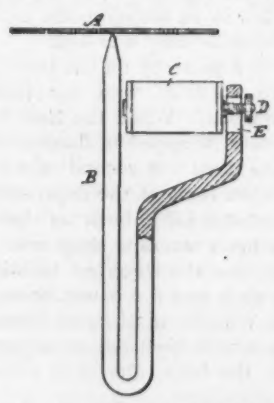


FIG. 17.—COLE—NO. 352,735.

and from the centre, but the slots extending inward and outward, respectively, less than half a radius, the central solid portion of disc remaining being recessed. The diaphragm rests upon the central and peripheral solid portions, being thus supported both at the centre and periphery.

W. R. Cole is well known in telephone circles as an inventor, and the Western Electric Company has purchased a number of patents

taken out by him in conjunction with W. A. Jackson. Fig. 16 shows a form of transmitter patented by him Oct. 19, 1886 (No. 351,250), the object of which is stated to give a strong undulatory current without any break in the connection, and thus obviate disagreeable sounds. The diaphragm rests upon a rubber ring *B*; a bridging piece *h* supports a polarized magnet *F* on trunnions; a carbon button *J* is pressed by the screw *K* against a platinum point *I*, secured to the diaphragm, the pressure being adjusted by the screw *L*. The claims are for a combination of the above details.

Another patent (No. 352,735) issued Nov. 16, 1886, is for a telephone shown in Fig. 17, the claim being for a receiving telephone

FIG. 18.—COLE—
NO. 352,806.

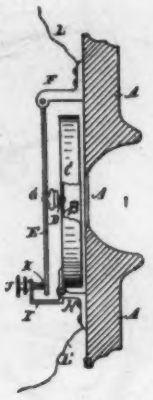


FIG. 19.—COLE—
NO. 386,965.

having a permanent magnet with one of its poles free and arranged at right angles to the diaphragm (*A*) and the other pole attached to one of the poles of an electromagnet, arranged with its axis parallel to the diaphragm. The inventor believes that by this means a more sensitive telephone is secured.

In a patent issued Nov. 16, 1886 (No. 352,806), for a microphone transmitter, shown in Fig. 18, the claim is made for an instrument very sensitive but which will not be materially affected by outside influences, jars, etc. The claim is on the curved spring bar shown, having a metallic contact point in the middle which rests on the diaphragm. Another patent (No. 386,965, dated July, 31, 1888), to attain the same object, substitutes a hinged bar, as shown in Fig. 19.

The Crocker-Wheeler Factory Destroyed by Fire.

The factory of the Crocker-Wheeler Electric Company at Ampere, N. J., was almost entirely destroyed by fire on Sunday afternoon, April 7. The fire broke out in some unexplained manner in the shipping building, near the centre of the plant. It being Sunday the works were shut down, and no one was in them but the watchman, who saw the flames and attempted to fight them with a patent fire extinguisher. He was overcome by the smoke and nearly lost his life, being rescued in an unconscious condition by the firemen. By this means valuable time was lost.

An alarm was given by a passerby on the track of the Delaware, Lackawanna & Western Railway, who ran nearly a quarter of a mile to the nearest alarm box. When the East Orange department arrived the buildings were wrapped in flames, and it was evident that nothing could save them. A second alarm was at once sent out, bringing out the entire force of the department.

The buildings were substantially built of brick and filled with costly machinery. The main machine shop was 400 feet long, and at right angles to this ran the electrical building, 250 feet long. Adjoining the machine shop was the power house, with a big Buckeye engine and Crocker-Wheeler multipolar dynamos.

More than 500 hands are thrown out of employment by the fire. Many of these lived in the little cluster of cottages and homes at Ampere Station.

The winding room and main machine shop buildings are practically destroyed, as well as the shipping department. The office building and pattern shop are uninjured. It is thought that the heavy machinery escaped with very little damage, for the reason that the building was but one story high, and the falling in of the glass roof would not materially injure the contents.

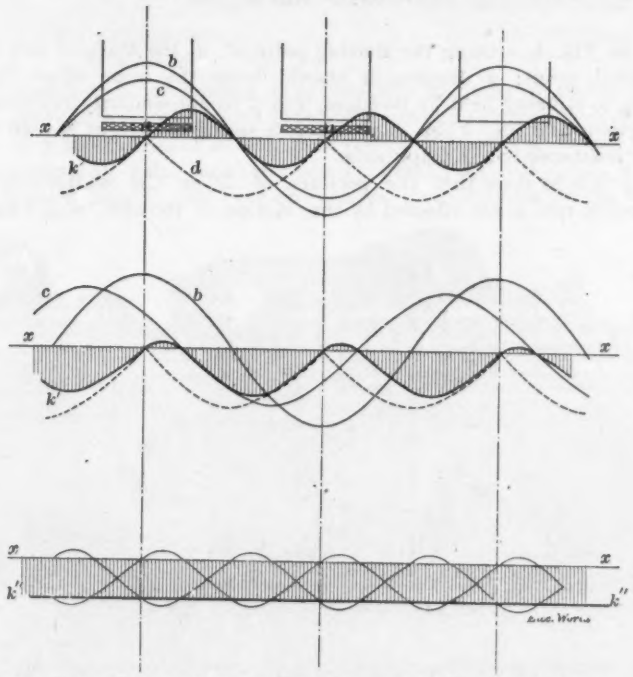
The total damage is unknown at present writing, but is fully covered by insurance. Temporary quarters will be secured at once to continue work on the many orders now on hand, and the reconstruction of the old building will be vigorously pushed.

Armature Reactions in a Simple Alternator Compared with That in a Multiphase Generator.

BY OSSIAN CHRYTRÆUS.

I am not aware that the armature reactions of simple and multiphase alternators have ever been represented comparatively, and as such a representation may be of interest, I will try to show graphically these actions on the fields of different machines.

It is apparent that the reaction from the armature on the field in an alternating current machine is not only dependent upon the current flowing, but also upon the position of the coils in regard to the poles. The most active position is when the conductors are between the poles, and its zero action when the conductors are under the poles. To get a graphical representation of this, let us assume that a direct current is flowing in the coil in Fig. 1, of a simple alternator, and through a curve represent its effect upon the field for different positions. This curve will then enable us to get the percentage of the ampere turns in the armature that are reacting upon the field. Let the ordinates to the curve *d* represent this. We will assume the curve to be a sine curve; it is not exactly so, but it is near enough. In the diagram, the sine curve *b* represents the impressed E. M. F. The curve *c* represents the current flowing and in phase with the E. M. F. We can now determine the reactive effect of the current, as the ordinates of the curve *c* represent the strength of the current, and the corresponding ordinates of *d* the percentage that is active. We thus get the curve *k*, which in the



FIGS. 1, 2 AND 3.—ARMATURE REACTION IN A SIMPLE ALTERNATOR COMPARED WITH THAT IN A MULTIPHASE GENERATOR.

diagram is reversed every time the conductors pass over the centre lines of the pole, because the same current acts in opposition to the field on either side. The reaction upon the field is then represented by the curve *k*; in other words, it represents the current that would have to flow through an extra coil on the field in order to produce the same effect upon the lines of force.

If the current in the armature is lagging behind the E. M. F., the current that would have to flow in the extra coil is represented by the curve *k'* in Fig. 2, derived from the current curve *c'* in a similar way as above.

Such a fluctuation of the lines of force as the armature reaction will naturally effect in the simple alternator must cause a loss due to eddy currents. Further, a machine that under no load would give a perfect sine curve, would give when loaded a distorted curve of impressed E. M. F.

The reaction in the two-phase generator is represented by combining the actions from the coils in both phases. These coils are 90 degrees apart, and the reactive action for each coil separately must be that of the simple alternator under the same current lag. Now let us assume, first, that there is no lag of the current in either phase behind its E. M. F. Then we have the same conditions as in Fig. 1, but we must combine the action from the two similar

curves *k* 90 degrees apart, and, as is easily seen, they must neutralize each other entirely.

If the current is lagging behind the E. M. F. equally in both phases, we have the conditions for each phase, as in Fig. 2. The resultant of these two combined is shown by *k''* in Fig. 3.

The effect of the armature reaction in a two-phase generator is, then, to produce a steady demagnetization on the field, which only varies with the angle of lag. If, instead of a two-phase, we were finding the reaction in a three-phase or any multiphase generator, it is apparent that we would get a similar result.

The Niagara Plant.

One of the 5,000-hp double inverted turbine wheels and the 5,000-hp electrical generator, at Niagara, were tested on April 6 in the presence of officers and stockholders of the Cataract Construction Company, the Canadian Niagara Power Company, the Niagara Falls Power Company, and the Erie Railway Company and others. The No. 1 turbine wheel was used. No current was generated, the fields not being excited.

The machine was started at 17 revolutions per minute and increased gradually to 32 revolutions. To generate the 5,000-hp 250 revolutions must be reached. The mass of steel and iron comprising the wheel, shafts and dynamo, estimated at 75 tons, was held poised on the bearings by the weight of water which strikes the turbines from below. Mr. Rankine, the secretary and treasurer of the power company, states that the results were wholly satisfactory.

Heat from Various Sources of Artificial Light.

The following comparison, compiled from data in Palaz's "Industrial Photometry" will be useful to electric light managers in presenting the advantages of the incandescent light, particularly for summer use. All of the numbers refer to sixteen candle power of light, and represent the number of pounds of water that will be raised 10 degrees F. in temperature by the heat given off in one hour's lighting:

Arc light, - - -	4	Gas, Argand burner,	380
Incandescent light, -	14	Candle, - - -	473
Kerosene, Argand burner,	331	Gas, butterfly burner,	511

No air, of course, is vitiated by the incandescent lamp, and a negligible quantity by the arc light. The other sources in producing sixteen candle power of light vitiate as much air as would four to seven men.

The Care of Storage Batteries.

BY R. MACRAE.

In the report of a discussion on storage batteries at the meeting of the Electric Light Association at Cleveland, contained in THE ELECTRICAL WORLD of March 2, Prof. Stine, after referring to the prejudice against storage batteries in this country, says:

"There also occurs during every charge and discharge a certain amount of chemical action which cannot be reversed, resulting in the eventual consumption of the plates, whose material, accumulated at the bottom of the cell, tends to produce short circuits.

"The separate plates of the elements should be so attached to the connecting bars that they may be readily removed for inspection or repairs. Good sulphuric acid should be used, free from metallic impurities, such as iron or arsenic, and particularly lead sulphate. If commercial acid is used, it should be purified by sulphuretted hydrogen or other means."

Prof. Elihu Thomson, in THE ELECTRICAL WORLD of March 3, 1894, says:

"The greatest disadvantage in the use of storage batteries is the fact that the cells require watching or constant attention to detect any incipient weakness.

"It is well to have the connections of a series of cells made so that any faulty cell can easily be disconnected, and if need be, removed from the set."

If so much depends on having the material used in the construction of a lead battery chemically pure, and such constant inspection is necessary as might be inferred from the above, it is not difficult to account for the prejudice against storage batteries referred to by Prof. Stine. A central station manager is not likely to invest in anything that requires such constant doctoring as indicated by Profs. Thomson and Stine. As a matter of fact, a lead battery, properly constructed and adapted to the work that it is to perform, does not require constant or any attention, other than to charge it after it is discharged. It is of course necessary that the charging and discharging be done in a proper manner. It is not desirable to have the plates and cells joined up in such a way that they can be readily removed for inspection and repairs; nor is it necessary to use chemically pure material in the construction of a lead battery in order to obtain good results. It is not easy to see what objection there is to sulphate of lead in a lead battery or what the result would be if sulphate of lead was not formed and reduced during the action of the cell. Any one having practical experience with renting storage batteries knows that when a new customer finds his battery exhausted, that the first thing he generally does is to fill it up with such chemicals as he may have at hand in order to avoid the expense of recharging, the favorite substances being nitric acid, chloride of ammonium and bichromate of potash. In such cases the degree of chemical purity necessary to put the battery in good working order is attained by immersing the elements for a short time in cold water, and filling up with fresh solution.

A storage battery of 480 cells that has been in constant operation in one of the telegraph offices here for the last two years was not connected up in such a way that the individual cells could be readily removed and repaired, but was joined together by fusing with a blowpipe. The material used in the construction of the battery contained the usual impurities found in commercial lead, lead oxide and sulphuric acid, but up to this time not one cell out of 480 has been removed on account of any defect whatever.

When a battery of storage cells shows incipient weakness, instead of looking up short circuits in individual cells all the positive elements in the battery ought to be renewed. If one plate or cell shows defects when the others are in good condition, the battery should be condemned and a type of battery installed that will not require patching up until it is time to put in a complete set of positive plates. The life of the positive plates in a properly constructed battery depends entirely on the rate of charge and discharge, and not at all on the amount of inspection that they receive and the readiness with which short circuits are detected.

With the early types of storage battery it was, of course, necessary that each plate could be readily removed for repairs. The method of making repairs was simple and effective. The plate causing the trouble was laid on the floor with a board placed on top of it. The electrician then jumped on the board, after which the plate was put back in the cell. Experience has shown, however, that it is better to give more attention to the original construction than to rely upon this method of keeping a battery in working order.

The criticisms of Profs. Thomson and Stine could be justly applied to the types of accumulators that were in use several years ago. During the past two years, however, a form of secondary cell has been put on the market from which the weaknesses referred to have been entirely eliminated.

Strassenbahnwagenuntergestelle.

If any of our readers, in looking over articles on electric railways in the German language, should come across the word *Strassenbahnwagenuntergestelle* they need not be alarmed or discouraged nor be afraid to use it in good society. Instead of getting at the subject directly, as is done in English, this single word relates quite a little story—a sort of riddle of which you are expected to guess the answer. The story is, briefly, as follows: In about the middle of the word we find that the object referred to has some connection with a car, and returning to the beginning it appears that this car is intended to run on rails (as cars usually do, by the way), that these rails are in the streets of a city, and that the car is supported on some structure; near the end it is explained that this supporting structure is below and not above the car, and finally it is added that it refers to the apparatus in general and not to any one form in particular. With the aid of this description it will not be difficult to guess correctly that the German writer would have said *trucks* instead, had he been privileged to use the English language.

A Priori Advantages.

Prof. Crookes, says Sir David Salomans, once made a significant remark to him, to the effect that had the electric light been universal at the present day, the candle, if suddenly introduced, would be thought a wonderful invention. The arguments advanced would be that it enables any person readily to obtain light in its simplest and most portable form, and without the use of cumbrous machinery, or the necessity of attaching the lamp to any fixed point by means of wires before it could be lighted. Recent claims for the new acetylene gas illustrate the point of above remark.

Electrical Power Transmission.—XX.

BY LOUIS BELL, PH.D.

In practical alternating circuits the curren wave is never truly sinusoidal, but consists of a main or fundamental wave with the odd (*i. e.*, 3d, 5th, 7th, etc.) harmonics of various amplitudes superimposed upon it. In nearly every case the third harmonic is the most prominent and is quite capable of causing resonance even to a dangerous degree if it happens to fall in with the frequency of the system. The extent of the rise in voltage, however, is very much less than that produced by resonance with the fundamental frequency. The point at which resonance occurs and its magnitude are found for the harmonics by the formulæ already given.

To facilitate computation the following table is given showing the inductance and capacity of ordinary overhead lines per mile in millihenrys and microfarads respectively. The wires are supposed to be of copper and to be suspended as a parallel pair at a distance of 18 inches, as in the case of the table of impedance factors. Within the range of ordinary practice varying the height above the ground makes no sensible difference in inductance or capacity.

Size. No.	Inductance.	Capacity.
0000	1.48	.0102
000	1.52	.0099
00	1.56	.0097
0	1.59	.0095
1	1.63	.0093
2	1.67	.0090
3	1.71	.0088
4	1.74	.0086
5	1.78	.0084
6	1.82	.0083

So far as the line is concerned the facts regarding resonance can be easily computed with tolerable accuracy. From the table it is evident enough that the line capacities are generally so small as to make the oscillation period so short as not to correspond with the frequencies in ordinary use except in the upper harmonics, which are generally of small moment although one case of severe resonance from a higher harmonic (probably the 7th) has come to the author's notice.

It must be remembered that not only the line capacity but the capacity of the receiving apparatus must be considered. The former is but small except in the case of underground or submarine cables, for which the capacities are likely to be from ¼ to ⅓ microfarad per mile, as ordinarily manufactured. High voltage translating devices like synchronous motors and transformers often may have static capacities of several tenths of a microfarad.

As a matter of fact, experience seems to show that one is not likely to stumble upon very serious resonance in overhead lines, although in cables it is easily possible. On the other hand, it is more than likely that resonance of a minor kind, mostly from harmonics, is far commoner than is generally supposed. High pressure alternating currents often show a tendency to jump across air spaces and insulation that is hard to account for otherwise. This tendency must not be confused with the occasional displays of atmospheric electricity on overhead lines. It is not uncommon to get somewhat severe shocks from an aerial line entirely disconnected from any machinery.

The most obvious way of avoiding trouble from resonance when it exists or is threatened is to vary the frequency, inductance or capacity so as to throw the oscillation period of the system and the frequency of the current far apart. The frequency is usually fixed by other considerations, but inductance and capacity are varied with the utmost ease. In fact, they are never constant in practice.

The readiest way of getting a clear idea of the inductance of a system is from its power factor, *i. e.*, the ratio between the apparent energy as found from voltmeter and ammeter readings and the real energy as given by a wattmeter. This not only gives the current which must be carried for a given amount of energy but measures the angle of lag between current and E. M. F. In fact,

$$\frac{\text{Energy}}{\text{Volt-amperes.}} = \cos\theta,$$

which gives the angle of lag at once. But in general

$$\text{Tan } \theta = \frac{2 \pi n L}{R}.$$

So that knowing the ohmic resistance of a circuit and its "power factor" we can get a tolerable approximation to its coefficient of self-induction, R being reckoned in ohms and L in henrys. As, however, the lag is determined by both inductance and capacity, the formula is principally of use in connection with individual pieces of apparatus.

From a practical standpoint it is quite out of the question to compute the total inductance of a proposed system on which any resonance effects depend, with anything like accuracy, since the character and amount of the apparatus is indeterminate. One can, however, gain from experience a tolerable idea of the probable lag in a mixed system, which will at least tell whether there is imminent danger of resonance. There is really little danger at ordinary frequencies unless the static capacity involved is large—several microfarads at least.

One other phenomenon in connection with alternating current work deserves notice here. Several years ago Sir William Thomson pointed out that the ohmic resistance of a copper wire was greater for alternating than for direct currents. This is for the reason that the current density through the cross section of the conductor is not uniform when the current is an alternating one. The propagation of any current is mainly along the surface of the conductor, and only after a measurable, though short, time is the condition of steady flow reached.

When the current rapidly alternates in direction the interior of the conductor is thus comparatively unutilized, for before the flow has settled into uniformity its direction is changed, and the original surface flow is resumed. The larger the wire and the greater the frequency the more marked this effect. Fortunately with the common sizes of wire and the frequencies ordinarily employed for power transmission work, it is quite negligible. At 60 periods the increase of resistance due to this cause in a conductor, even half an inch in diameter, is less than one-half of one per cent. Any line wire that is allowable on the score of its impedance factor will be unobjectionable on this account as well. Only occasionally, as in bus bars for low voltage switchboards, is it worth considering, and in such case the use of flat bars, half an inch or less thick, will obviate the difficulty.

We have now investigated all the important factors that enter into the design of a transmission line, whether for direct or alternating currents. Let us review them with the idea of seeing how they enter into practical cases. First comes the all important question of initial voltage, involving the choice between the direct generation of the working pressure or its derivation from transformers if alternating currents are used. We have already seen the practical limitation of voltage for direct currents. With alternators the commutator troubles are absent, and the limitations are those imposed by generator design. The higher the voltage of a dynamo the more space on the armature must be allowed for insulation, thereby cutting down the output of the machine. Hence the practicable voltage depends on the size of the generator.

In a general discussion it is difficult to make exact statements as to what can or cannot be done, but experience seems to show at present that 3,000 to 5,000 volts is the greatest pressure that can economically be derived from the generator, the latter only in very large units. Higher voltage than this has been attempted, but there is good reason to believe that the reduced output and increased cost of construction lead to a higher cost per kw output than if low voltage generators with transformers were employed.

For present purposes, then, we may assume that in a large proportion of cases the voltage of the generator cannot well be above 3,000-3,500 volts. With raising transformers 5,000 to 10,000 volts is known to be a practicable pressure. At some particular distance, then, in each case, the annual interest and depreciation charge against, say a 3,000-volt line, will equal the interest and depreciation charge against, say a 10,000-volt line, and its raising and reducing transformers. For a fair comparison two things must be noted—first that 3,000 volts is an available pressure on a working circuit, so that it has the advantage over 10,000 volts, of both sets of transformers—second, that the systems must be of the same efficiency, *i. e.*, the line loss in the first case should be equal to the losses in both line and transformers in the second case.

The exact distance at which the costs by the two methods become equal must be computed from the data above outlined in each individual case on account of the variations introduced by size of units, cost of copper and transformers, delivered, differing conditions of depreciation, and so on. The distance, however is generally longer than would be at first sight supposed. Assuming an equal rate of interest and depreciation in each case, a few hundred horse-power as the amount transmitted and current prices of copper and larger transformers, we arrive at the following approximate result: At about

7 miles 3,000 volts from the generator and 10,000 volts with raising and reducing transformers become equal in cost. This distance becomes between 11 and 12 miles if 5,000 volts only are derived from the transformers. Generators wound for 4,000 or 5,000 volts generally will require reducing transformers for the working circuit, so that they have the advantage of the raising and reducing system by only one set of transformers.

In most cases it is desirable either to generate a voltage which can be used on the working circuit or to use from 5,000 to 10,000 volts derived from transformers. So much for the selection of a proper line voltage.

As to loss in the line much has been said already, and the best advice that can be given is to make a few trial computations along the general lines indicated. Almost every case will require special treatment in certain particulars, depending on the conditions of service. For example, a common complication is the supply of power or light or both at a point perhaps halfway along the line. Then, according to the amount and kind of service it may be desirable simply to tap the line, to tap the line for power and use a motor generator for lights, to establish a sub-station with regulating apparatus, to compound the generator for the point in question and use either of the above methods at the end of the line, to instal rotary transformers or to run a separate line with regulators at the generating station.

The line structure should preferably be of bare copper wire carried on wooden poles. Do not go underground unless you have to do so. It may be necessary to insulate portions of the wire, but it is best not to put much faith in an insulating covering. Instead, it is desirable to make a very thorough job of insulation at the supports, and provide for the easy inspection of the line.

In using alternating currents inductance in the line must always be considered. Practically it means raising the voltage of the generator or raising transformers by a few per cent., unless a considerable part of the load is in synchronous motors which can be employed to counteract the inductive drop. In nearly every case its real importance is small in spite of its scaring the uninitiated now and then.

So, too, with inductive load. Its real effect is merely to increase the current in the line by a small amount, usually less than 10 per cent., and to demand increase of excitation at the dynamo. If this is so designed as to regulate badly, an inductive load will render it difficult to keep a uniform voltage. On the other hand, a generator capable of holding its voltage from no load to full and inductive load with an increase of only 20 or 25 per cent. in the exciting current will give no trouble whatever. The total net result of inductance in line and load is to call for a well-designed generator with good regulation and a reasonable margin of capacity. One who knowingly installs anything else deserves all the troubles that inductance can produce.

Rise in voltage on throwing off the load or through distortion of the current wave by an inductive load can be reduced to insignificance by employing a proper generator as above noted. Aside from this, a mixed load particularly if consisting in part of synchronous motors, seldom has a bad power factor or great and sudden changes in amount.

As regards static disturbances, few overhead systems have capacity enough to give cause for alarm. Difficulties are to be looked for chiefly on very long lines, longer than any now in use, and those composed in part of underground or submarine cables. In these cases one can sometimes know the conditions well enough to calculate the actual result in rise of voltage. More often, the data are incomplete, and the simplest way out of the difficulty is to try the effect of varying the capacity of the system before it goes into regular operation. If the addition of a condenser, say of $\frac{1}{3}$ microfarad, makes a sharp variation in the voltage, look out for resonance and investigate the capacity of the system step by step. A change of capacity or inductance can be made sufficient to avert any serious danger of resonance.

We may now pass to the practical calculation of a line. Case I.—The simplest possible case is the transmission of direct current over a short distance. Let it be required to deliver 200 hp to a machine shop for operating machinery and a small tramway over a distance of one and a half miles, power to be about equally divided between small motors and tramway. Source of power—water power—owned outright by the company, and ample in amount. Load on small motors steady, on tramway very variable. In a case of this kind the use of direct current is advantageous, since with plenty of power considerable drop can be permitted and the use of any alternating system would involve changing to direct current for the tramway. For use in a machine shop the speed of the motors need not be very uniform, so that there will be no especial difficulties of regulation. On account of size of motors 500 to 600 volts will be the highest permissible voltage.

There are several courses open in determining the drop. The easiest is to assume for the final voltage such a value as will give the greatest drop compatible with convenient regulation, and the voltage delivered by a standard railway generator. A special generator is objectionable on account of both first cost and difficulty of repairs. The generator can be counted on for 600 volts maximum. If, therefore, we run it at a normal no-load voltage of 550, and over compound about 10 per cent., we shall get no more than about 550 volts at the motors. During the time that the tramway is working we can let the voltage fall to 500, for which the tramway motors give their normal output without interfering materially with the regulation of the other motors. We take the maximum drop then at 100 volts. The amount of power to be delivered at full load is 200 hp.

Taking the average commercial efficiency of the motors at 80 per cent., the electrical hp to be delivered is 250, which equals very nearly 187,500 watts at 500 volts. The current, therefore, is 375 amperes. To allow for sag, joints and waste, we should take the mile as about 5,400 ft. instead of 5,280. We are now ready to determine the cross section of the wire by the formula already given. We then have

$$\text{cm} = \frac{16{,}200 \times 11 \times 375}{100} = 668{,}250.$$

Looking now in our wire table, we find that the nearest convenient approach to this cross section is three No. 0000 wires, each of 211,600 cm. We might reinforce these by a No. 5 wire and get almost exactly the amount required, but the game is hardly worth the candle, since we are working for minimum first cost, and a very trifling increase of drop is not worth considering, particularly as the maximum load will be for only a few minutes at a time. A nominal 200-kw generator will serve our purpose if built as standard railway generators are, to stand small and temporary overloads at any time. The cost of the copper for such a circuit is considerable. 48,600 ft. of No. 0000 will be required, weighing, when insulated, as it generally would be in running into a town, about 750 lbs. per 1,000 ft. The total weight would then be 36,450 lbs., costing, at 12½ cts. per lb., $4,556, nearly $23 per hp delivered.

Case II.—A cotton mill is operated by steam, coal costing about $5 per ton, the actual brake horse power required to drive the machinery being 650. Speed must be constant, load is very uniform, and any reduction of available horse power cuts down the output, all of which is badly needed to fill contracts. A cheap water power, distant 22,000 ft., is acquired by the mill owners. Sixteen thousand cubic ft. of water is available, and the greatest head that can be utilized is 30 ft. At the given price for coal electrical transmission will certainly pay. The full 660 hp must be delivered, or the power will have to be supplemented by steam, unless part of the looms are shut down.

The given amount of water will produce, when utilized in first-class turbines, almost exactly 800 mechanical hp. Two turbines are used for security against breakdown, and each runs 150 revolutions per minute. The commercial efficiency of the plant must then be at least $\frac{600}{800} = 82.5$ per cent. Taking 300 kw units for generators and motors we can be sure of a commercial efficiency of .93 in each machine. This limits the efficiency of the line to not less than 95.4. It is evident at once that direct coupled generators must be used, since the 4 or 5 per cent. lost in belting would be quite inadmissable.

As to voltage, it is evident that the highest available in a 300-kw unit should be used. Without going into special windings, the maximum would be, say, 3,000 over compounded about 10 per cent., giving 3,300 at the brushes. At the assumed efficiency of motors there must be delivered to them 529 kw. At 4.6 per cent. drop in the line 168 amperes must be the current. All question of inductive drop may be neglected, since the motor field can be adjusted to compensate for it. Taking the actual length of circuit as 45,000 ft., and employing the formula as in Case I., the cross section of conductor comes out as 547,100 cm.

This is very nearly met by three No. 0000 B. W. G. wires. Wire drawn to this British wire gauge can be readily obtained without increased cost. The combined section of the three varies but a little over 1 per

cent. from that required, hence will serve excellently. Supposing bare wire to be used, the weight of each conductor per thousand feet is 547 lbs. The total weight of copper is then 73,845 lbs., costing, at 12 cents per lb., $8,861. Any increase in the loss in the line will cause a failure to deliver the required power and necessitate the operation of a subsidiary steam plant, or the shutting down of nearly a score of looms for each per cent. decrease in efficiency. Doubling the line loss would save $4,430, but at the cost and trouble of a 40-hp steam plant, or the loss of the output of 75 or 80 looms. In a case of this kind the easiest way of reducing the cost of line would be to use the three-phase synchronous system, or the three-wire two-phase, either of which would save a quarter of the above copper at the same efficiency.

Case III.—It is desired to deliver for general service in a city 1,000 kw from an ample water power 20 miles distant. Power is to be used for arc and incandescent lighting, and a motor service of unknown amount, possibly as great as 500 hp; 3,000 to 4,000 hp can be obtained at the power station, and allowance must be made for extensions.

On account of reduced cost of line the three-phase system is desirable, using the distribution by secondary mains at about 220 volts between wires, using a balance wire for lamps. This requires a little less than 30 per cent. of the copper needed on the two-wire system with the same voltage at lamps. Evidently raising and reducing transformers should be used, and the climatic conditions are favorable enough to allow 10,000 volts on the line. We should first decide on the generators. Six hundred kw is a convenient size, two being used for the total plant. The voltage should be moderate, say, 500 volts. With this preliminary, let us figure the line. We can conveniently lose about 10 per cent. of the energy, say, 5 per cent. in the two banks of transformers and 5 per cent. loss in the line. The voltage at the receiving end will then be 9,500, with 10,000 at the raising primaries. As to regulation, the distributing system is worked from a sub-station where the regulating is done.

Since the copper required is ¼ of that needed for a two-wire system at the same voltage, each of the three wires will have one-half the cross section of either wire on the two-wire system. We may, therefore, use our previous formula if we take account of this factor ½. The simplest way of doing it is to take the single distance of transmission instead of the double distance. As to the current in the formula, it must be the equivalent single-phase current. If we write $\frac{W}{V}$ instead of C, we shall avoid all confusion on this score. Our formula then becomes

$$\text{cm} = \frac{D \times 11 \times \frac{W}{V}}{V_1}$$

wherein D is the distance of transmission, W the watts received, V the voltage of reception, and V_1 the volts lost in the line. In our case $D = 108,000$ (the mile being taken as 5,400 ft.) $V = 9,500$, $V_1 = 500$, $W = 1,000,000$. Then cm $= 250,000$ (nearly).

But we must remember that our load is a mixed one of lights, and probably both synchronous and induction motors. Hence it will have an inductance. Hence a current somewhat larger than that given by $\frac{W}{V}$ must be taken. With fairly good luck in our proportion of synchronous motors, 5 per cent. increase will be enough to allow. At worst it could hardly be greater than 10 per cent., which would mean a very small increase in ohmic drop. Taking it at 5 per cent., we add that amount to our cross section and obtain 262,500 cm. The nearest approach to this with standard wires is two No. 00 = 266,000 cm. This is ample.

Now as to inductive drop. At worst the impedance factor of the line will not be greater than 1.79, with 60 periods and wires strung 18″ apart. Therefore, a rise of less than 4 per cent. in our generator voltage will take care of the inductance in the line. As to capacity, each pair of wires will have a capacity of less than $\frac{1}{100}$ microfarad per mile, so that we need not borrow trouble on the score of resonance. The effect of total inductance on the generator is small, since the power factor of the system is likely to be as great as .95, and if the generator is even tolerably well designed, a few per cent. increase in excitation will compensate for this. Now computing the total amount of copper we find it to be 261,144 lbs., costing, at 12 cents per lb. for bare wire, $31,337.

We now have a working line laid out, and feel sure that no contingencies we are likely to meet will cause the drop to vary much from 5 per cent., since within the plausible range of power factor that can be found in a mixed plant both line and generators are well able to take care of the variations. The net result of inductance has been to increase our allowance of copper by 5 per cent., and to require 10 or 12 per cent. margin of excitation and current capacity in our generator.

This may seem a rough and ready process for figuring a transmission line, but it gives a safe and conservative result, as nearly exact as the data generally available for a new plant permit. If the capacities and inductances of the future system could be pre-determined, we could take their vector sum and compute a small correction to our factor of safety in the generator. If the future load were exactly known we might wish to change the drop slightly. No exact data are available under ordinary circumstances, hence we must rely on our judgment in selecting the drop, and factor of safety in the generator, which, unless it be downright bad in design, will have margin enough to meet any reasonable requirements.

It Depends on Oneself.

The *Engineering Magazine* editorially makes the following statement: "We do not expect to live to see cars running at 120 miles per hour by any now known mode of propulsion." We do not know how old that writer is at the present time, nor the state of his health, and, therefore, we cannot say whether we agree with him or not; as steam locomotives, we believe, have been known to have attained a speed of 114 miles an hour, those of us who are not as old as that writer, or, perhaps, in better health, may hope to live to ride at that rate in cars driven by electric power.

Electrodynamic Machinery—XXXI.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

161. Besides the eddy currents set up in the armature and in the conducting masses of the metal on the armature, they also occur in the edges of the pole pieces of the field magnets, both in the case of dynamos and motors. The strength of these eddy currents is greater in the pole which is approached by a generator armature, and in that which is receded from by a motor armature, as is evidenced by the fact often observed, that, although both polar edges become warm during the action of the machine, one edge becomes warmer than the other. The reason for this difference will be considered later.

162. The tendency to the development of eddy currents in pole pieces is increased when the armature is changed from a smooth core to one of the toothed-core type. The reasons for this are two-fold; in the first place, in the toothed-core armature the core is brought nearer to the pole face, so that all magnetic disturbances in the core are more likely to set up corresponding disturbances in the poles; in the second place, because the revolving teeth set up waves of magnetization in the polar surfaces, thus giving rise to the development of eddy currents. Consequently, the change from a smooth-cored to a toothed-cored armature suppresses the eddy currents in the wire on the armature, but creates, or tends to create, eddy currents in the pole pieces.

163. In some types of machines the pole pieces are grooved or slotted, so as to check the development of eddy currents, just as the armature is in effect grooved or slotted by the use of laminated cores. In fact, some field magnets are constructed of an iron frame with receptacles within which are placed the pole pieces formed of a number of iron plates bolted together, the laminations extending in the same direction as those in the armature beneath.

It will be evident that there can be no tendency to set up eddy currents in the solid cores of the field magnets excited by steady, continuous currents. Consequently, no advantage is derived from a lamination of field magnet cores at distances beyond the influence of magnetic changes produced by the teeth or conductors on the revolving armature.

164. Besides the losses in the iron masses of a dynamo due to eddy currents there are others in the same masses due to magnetic friction or *hysteresis*. This latter loss, like the others, is dissipated as heat.

The losses due to hysteresis occur in nearly all forms of dynamo-electric machinery. In continuous current generators they are practically limited to the armature; in some forms of alternating current machines they exist both in the armature and field, and are especially present in alternating current transformers. It becomes, therefore, a matter of no little importance to thoroughly understand the nature of this source of loss.

165. A certain amount of energy has to be expended in order to magnetize a bar of iron. This energy resides in the magnetic flux passing through the magnetic circuit of the bar. The energy is transferred from the magnetizing circuit by the production of a counter E. M. F. in the magnetizing coil, and this counter E. M. F. e (usually very small), multiplied by the magnetizing current strength I at that moment, gives as the product $e\,I$, the activity expended in producing the magnetic field. As soon as the full magnetic flux is established, the counter E. M. F. ceases, being dependent upon the rate of change of flux enclosed, so that no more energy is expended in the iron, and the current only expends energy as $i^2 r$ in heating the magnetizing coil. When the magnetizing current is interrupted, say by short circuiting the source of E. M. F. in the circuit, the magnetism in the bar tends to disappear, and as the magnetic flux diminishes an E. M. F. is set up in the coil tending to prolong the action of the waning magnetizing current. In other words, the E. M. F. set up in a circuit by the waning magnetic flux is such as will tend to do work on the current, with an activity of the type $e\,i$ watts, and in this manner restore to the circuit the energy expended in the magnetization. Were all the energy in this case returned to the circuit, there would be no loss by hysteresis. As a matter of fact, however, while practically all such energy would be returned to the circuit if the coil magnetized air, wood, glass, etc., yet, when the coil magnetizes iron, although a greater magnetic flux is obtained, yet some of the energy is not restored, but is expended in the iron as heat.

166. It is now generally believed that each of the molecules in a mass of iron is naturally and permanently magnetized, so that each molecule may, therefore, be regarded as a molecular compass needle. In the ordinary unmagnetized or neutral condition of iron, these separate molecular magnets possess no definite alignment, and, consequently, neutralize one another's influence by forming closed loops or chains. When the iron becomes magnetized by subjection to a magnetizing force, these loops break up and become polarized or aligned, all pouring their magnetic flux in the same direction, *i. e.*, parallel to the magnetic axis. When the magnetizing force is removed the molecular magnets tend to resume their old positions; and if they did resume exactly their old positions, the magnetism in the iron would entirely disappear on the removal of the magnetizing force, and all the magnetic energy would be restored to the circuit. In point of fact, however, they do not exactly resume old positions, but take new intermediate positions, in virtue of which a certain amount of *residual magnetism* is left in the bar.

167. When now the magnetizing force is reversed by reversing the current through the magnetizing coil, the molecules are forced around, and breaking suddenly from their positions, fall into new positions either with oscillations or with a frictional resistance to the motion that dissipates energy as heat. The energy thus lost by molecular vibration or molecular friction cannot be returned to the circuit. Consequently, a loss of energy occurs in the circuit supplying the reversing magnetizing force, at each reversal of magnetism in the magnetized iron, since the opposing counter E. M. Fs. developed in the coil during magnetization and demagnetization are not equal, and the energy so lost results in an increase in temperature of the iron. By *hysteresis* is meant that property of iron or other magnetic metal whereby it tends to resist changes in its magnetization when subjected to changes in magnetizing force. That is to say, when a mass of iron is successively magnetized and demagnetized, or passes through cycles of magnetization, the magnetic intensity in the mass *lags behind* the impressed magnetizing force. The word hysteresis takes its origin from this fact, since it is derived from a Greek word meaning to lag behind. This phenomenon is called hysteresis, and the loss of energy due to this cause is called hysteretic loss, or loss of energy by hysteresis.

168. When iron undergoes successive magnetic reversals the amount of hysteretic loss is found to depend upon the maximum magnetic intensity in the iron at each cycle, that is to say, upon the maximum value of $\mathfrak{B}$. As $\mathfrak{B}$ increases, the amount of work that has to be expended in reversing the magnetization increases, and if we double the value of $\mathfrak{B}$ we practically treble the amount of work that has to be expended. It was first pointed out by Steinmetz as a consequence of this relation, that the hysteretic loss varied as the 1.6th power of $\mathfrak{B}$, or as $\mathfrak{B}^{1.6}$, the formula for the amount of activity expended in one cubic centimetre of magnetic metal being $P = n\,\eta\,\mathfrak{B}^{1.6}$ watts. Since the same loss of energy occurs in a cubic centimetre during each cycle, the more rapidly the cycles recur, the greater will be the wasteful activity, and n in the above formula expresses the number of complete cycles through which the iron is carried per second. The co-efficient η is the *hysteresis co-efficient* for the metal considered, and has to be determined experimentally. It may be regarded as the activity in watts which would be expended in one cc of the metal when magnetized and demagnetized to a flux density of one gauss at one complete cycle or double reversal per second. The following table gives the values of this co-efficient and also the amount of hysteretic loss produced in a cubic centimetre and in a pound of ordinary good commercial sheet iron at various frequencies and intensities.

TABLE SHOWING THE HYSTERETIC ACTIVITY IN GOOD, SOFT SHEET IRON OR STEEL UNDERGOING ONE COMPLETE MAGNETIC CYCLE PER SECOND, IN WATTS PER CUBIC CENTIMETRE, WATTS PER CUBIC INCH AND WATTS PER POUND, FOR VARIOUS MAGNETIC INTENSITIES IN GAUSSES AND IN WEBERS PER SQUARE INCH.

Webers, per sq. in..	6,452	12,900	19,360	25,810	32,260	38,710	45,160	51,620	58,060	64,520	70,960	77,420	83,860	90,320	96,770	103,200	109,700	116,100
Gausses [$\mathfrak{B}$]	1,000	2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	11,000	12,000	13,000	14,000	15,000	16,000	17,000	18,000
Watts, per cc.	1.58×10^{-5}	4.78×10^{-5}	9.15×10^{-5}	1.45×10^{-4}	2.07×10^{-4}	2.78×10^{-4}	3.55×10^{-4}	4.40×10^{-4}	5.31×10^{-4}	6.28×10^{-4}	7.31×10^{-4}	8.40×10^{-4}	9.55×10^{-4}	1.08×10^{-3}	1.20×10^{-3}	1.33×10^{-3}	1.47×10^{-3}	1.61×10^{-3}
Watts, per cubic in.	2.59×10^{-4}	7.84×10^{-4}	1.50×10^{-3}	2.38×10^{-3}	3.40×10^{-3}	4.55×10^{-3}	5.82×10^{-3}	7.20×10^{-3}	8.69×10^{-3}	1.03×10^{-2}	1.20×10^{-2}	1.38×10^{-2}	1.57×10^{-2}	1.76×10^{-2}	1.97×10^{-2}	2.18×10^{-2}	2.41×10^{-2}	2.64×10^{-2}
Watts, per lb.....	9.17×10^{-4}	2.78×10^{-3}	5.32×10^{-3}	8.43×10^{-3}	1.21×10^{-2}	1.62×10^{-2}	2.06×10^{-2}	2.56×10^{-2}	3.09×10^{-2}	3.65×10^{-2}	4.25×10^{-2}	4.89×10^{-2}	5.56×10^{-2}	6.26×10^{-2}	6.99×10^{-2}	7.75×10^{-2}	8.53×10^{-2}	9.35×10^{-2}

It is to be observed that the table represents average samples of good commercial iron, and by no means the best quality of iron obtainable.

169. As an example of the application of this table, suppose that it is required to estimate the power expended in hysteresis during the rotation of the armature of the octopolar generator represented in Fig. 125, the weight of iron in the armature being 2,700 lbs.

At the maximum intensity of 9,500 gausses, or 61,290 webers per sq. in., the table shows that the hysteretic activity per pound at one cycle per second is about 3.4×10^{-3} watts. In each revolution of the armature there would be eight reversals, or four complete cycles, and at 2,867 revolutions per second, the frequency of reversal would be 11,468 cycles per second. The total hysteretic activity is, therefore,

$$P = 2{,}700 \times 3.4 \times 10^{-3} \times 11.468 = 1{,}053 \text{ watts.}$$

This would be the hysteretic activity in the armature when generating 155.7 volts. When generating a lower E. M. F., the flux intensity in the armature would be reduced, as well as the hysteretic activity.

170. Hysteresis, therefore, occurs when a mass of iron undergoes successive magnetizations and demagnetizations, and this is true whether such are caused by the reversal of the magnetizing current, with the mass at rest, or by the reversal of the direction of the mass in a constant magnetic field. Consequently the revolutions of the armature of a dynamo or motor, the successive magnetizations and demagnetizations of its core, are accompanied by a hysteretic loss of energy.

The amount of this hysteretic loss increases directly with the volume v of iron in the armature in c. c., the number n of revolutions of the armature per second, the hysteretic coefficient η of the iron employed, and the 1.6th power of the maximum magnetic intensity in the iron; for it is evident that in one complete revolution of the armature its direction of magnetization will have undergone two reversals, provided that the field is bipolar. In a multipolar field the number of reversals increases with the number of poles p, and the hysteretic activity becomes $P = \frac{v\,\eta\,n\,p\,\mathfrak{B}^{1.6}}{2}$ watts. In the case of a generator, this activity must be supplied by the driving power, and in the case of a motor by the driving current.

171. When a generator armature is at rest in an unmagnetized field, the *torque*, *i. e.*, the twisting moment of the force which must

be applied to the armature in order to rotate it, is such as will overcome the friction of the journals and brushes. When, however, the field is excited so that the armature becomes magnetized, the torque which is necessary to rotate the armature is increased even when the armature is symmetrically placed in regard to the poles. This extra torque is due to hysteresis, and is equal to

$$q = \frac{v\,y\,p\,(\mathfrak{B}^{1.6}}{4\,\pi} \text{ joules.}$$

172. The total expenditure, therefore, of power in an armature core is the sum of the hysteretic and eddy current loss. The former increases as the speed of revolution directly, but the latter, as already pointed out, increases as the square of the speed. Consequently, if we have an unwound armature core and rotate it on its shaft through a field which is at first unexcited, we expend an activity which might be measured, and which would be entirely frictional loss. When the field is excited we expend activity against friction, hysteresis and eddy currents combined. By varying the speed of rotation, and observing the rate at which the activity given to the rotating armature increases, it is possible to separate the three descriptions of losses from each other.

173. Although, as we have seen, the hysteretic loss increases with the 1.6th power of the intensity of flux, yet it is stated to have been found experimentally that when a mass of iron, such as an armature, is rotated in a sufficiently powerful magnetic field, the hysteretic loss entirely disappears, owing to the supposed rotation of all the elementary molecular magnets about their axis during the rotation of the armature without their losing parallelism, and consequently without any molecular oscillation and expenditure of magnetic energy as heat. So far as experiments have yet shown, this critical intensity in the iron is above that which ordinary dynamo or motor armatures attain, so that under practical conditions the 1.6th power of the maximum intensity determines the hysteretic loss.

174. From an examination of the formula expressing the hysteretic activity in the armature, it is evident that the activity might be decreased by a decrease either in the number of poles, the speed of revolution, the flux density, or the hysteretic coefficient. Since, however, in any machine the first three factors are practically fixed, it is important that the remaining factor, or hysteretic coefficient, should be kept as low as is commercially possible. For this reason, whenever the hysteretic loss is a considerable item in the total losses of the generator, care is taken to select the softest iron commercially available, in which the hysteretic coefficient is a minimum.

175. We have already referred to the increase in temperature of the edges of the field magnet poles during the operation of a dynamo armature, and have ascribed the cause of such heating to the development of eddy currents locally produced there. It is to be remarked, however, that some of the heat in such cases may be ascribed to true hysteretic changes in magnetization.

(To be continued.)

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Electrical Condition of Buried Conductors Due to Leakage Currents from Electric Railways.—IV.

BY W. STUART-SMITH.

These tests along the S. M. road were made with a double scale Weston voltmeter reading to five volts on one scale and 150 volts on the other. It was arranged in a box with a two-point switch and small reversing switch. There were two outside contacts to which permanent connection could be made at each testing point, and generally the five-volt scale was used, and small differences could be easily manifested. In case the readings approached the upper end of the scale a movement of the two-point switch transferred the reading to the larger scale. When beginning the tests along the Metropolitan road an instrument having a scale of 75 volts only was used, and the tests along this road were finished with an instrument having a 30-volt scale. These less sensitive instruments may account for the fact that generally along the Metropolitan road the pipes were found neutral until the gas terminals were being approached.

Along this road no ground readings were generally obtained until Van Ness avenue was reached, where the pipes were a half volt + to the ground and neutral to each other. This ground reading diminished slowly but was still appreciable at Market street, twelve blocks from the electric road. A few blocks further west a similar condition was found. It was also peculiar that on Ellis street, from Larkin to Gough, the pipes were + to the Ellis street rail on the north side of the street and — to the rail on the south side. The cause of this was not understood, but later tests probably offered some explanation.

These tests were made under direction of the San Francisco Gas Company and only extended as far as the terminals of the gas pipes. It so happened that these limits were just at the points where the pipes began to be permanently + to the track, and the regions dangerous to pipes were not explored. Shortly after this series of tests was completed the Market Street Company's Mission & Third Street line was started and a new factor brought in. The location of this company's power house will be noted. A negative wire was led out from the power house and connected with the Brannan street track between Ninth and 10th streets. No cars were run on Brannan street, but it was bonded and acted as a return for the Third street branch. The potential of the Brannan street track was so far lowered that the pipes were + from the terminus near the power house to Fourth street. Four negative wires were led on poles to 16th and Mission streets and there connected to the track for a return for that portion of the road. In virtue of these wires the pipes were + to track from about 11th to 24th streets.

After the Market Street Company had started their system and the fall rains had come and the conductivity of the ground presumably increased the Spring Valley Water Company decided to have a series of tests carried out with a view to determining what changes had taken place since summer along those portions of the lines which had previously been tested, to determine the extent of the danger territory in the neighborhood and determine upon methods for obviating the danger that might exist.

The work was placed in the hands of the author with instructions not to assume that any conditions remained as they were during the previous tests, but that every fact should be determined anew, and the tests continued until all possible information was obtained.

During the previous tests the search for potential relations had been the main thing, the fact of universal drop of potential not having been discovered until near the close of the tests. In the second series the tests for drop of potential were given first place, the direction of current flow in the pipes being recorded at every street corner over wide areas. This was generally done, not simply in one direction, at a street crossing, but from every corner, so that at nearly every street crossing the current direction was known in all four directions.

In many places along the lines of the roads the same was done every 100′ from block to block. As will be seen, the time so employed was by no means wasted, but some valuable data were obtained.

Some of the results of this investigation may be passed over in a few words. As the tests along the lower part of the Metropolitan road did not show a potential relation to exist between the pipe systems while a potential difference everywhere existed along the line of the S. F. & S. M. road, it was assumed that the difference was due to the heavy current introduced into the pipes along the latter road by means of the wires between track and pipe, and it was thought that if these wires were cut off the potential relation would disappear, and it was considered doubtful whether any drop in pipes could be obtained (no tests for drop had originally been made along the Metropolitan road).

It was therefore determined to locate and cut off these wires, but in order that any changes found might be certainly laid to the door of the wires some preliminary tests were made both along the line of the Mission and S. M. roads. The wires were then cut off and tests begun under the impression that great changes would be found, but to the author's surprise there was no change whatever except in the immediate vicinity of what had previously been the wired points.

The potential difference between pipe systems was as great as it had previously been and the drop of potential remained practically unchanged. The pipes were + to ground as before, and at the terminals of the gas pipes the relations indicated that practically the same current was being passed to water pipes. It seemed certain that with the wires off the current in the pipes had not diminished. This was probably due to the fact that as the wires did not introduce current to greatly reduce the potential difference between track and pipes the leakage was greater. Facts later discovered showed that the presence or absence of an *occasional* wire where the track is + to the pipes is a matter of little consideration one way or the other. With closely wired points it is a different matter.

It will be needless to give much, if any, data regarding the drop of potential. Sufficient to say that there were few places within considerable distances where a very appreciable drop could not be

obtained over 100′ of either gas or water pipe. The drop generally varied from about 1-60 volt to two volts, as much as 1½ volts being obtained over 24 feet. Generally it averaged about 1-10 to ⅓ volt, but was generally considerably more immediately after a hard rain than if it had not rained for some days, thus indicating increased leakage with very wet soil.

During the summer tests several wired points previously named were located along the lower San Mateo road, but in order to be certain that they were all out tests for drop of potential were begun at Stewart and Market streets and continued up Stewart under the impression that when a point was found where the current direction reversed, *i. e.*, from which the current flowed in both directions, a wire would be found connecting track and pipes. Such a point was soon located about 200′ south of Market and by careful testing over individual points of the water pipe a section was soon found that was + to sections on either side of it. This was confidently uncovered with a view to cutting off the wire, and there was some chagrin at discovering no wire. Something had evidently gone astray. A further examination showed a water service leading out of that section and passing under the tracks to a house on the opposite side of the street.

There was no wire, but, nevertheless, there was a point of intake of a considerable quantity of current, and it was evident that simple reversal of current direction was not enough to locate wires. Generally, however, at such points of intake by leakage the potential difference between pipe and track was much less reduced than when a wire was present, and by careful testing wires could be located.

It will be noted that the Mission street and S. M. roads cross at Stewart and Mission.

After crossing Mission street and testing further south on Stewart the readings began to be very erratic. Contacts would be made and the drop determined, and while the instrument was being watched to note any changes in value suddenly there would be a reversal denoting that the current direction had suddenly reversed. This was very puzzling at first, but the facts were noted, and continued tests on Stewart street demonstrated the fact that there were no wires there, but the points of intake of current were frequent.

After the tests on Stewart street were completed tests were made on Mission to determine if possible the cause of the reversals of current direction found on Stewart street and which could not be accounted for by any movement of cars on that street. It was found that leakage points were frequent along the Mission road, and that the current reversals were due, first, to a current in the pipes received from the S. M. road, then from the Mission road. This was rather unexpected because the construction of the Mission track is excellent. The rails are heavy and the joints all triple bonded.

Careful measurements were made all the way out Mission street and it was found that frequently at the street corners the current would flow away from the crossing in all four directions, then perhaps in the next block the current would flow toward the street crossings four ways from the middle of the block.

In some cases two points would be found in a block from each of which the current would flow toward the corners and also toward the middle of the block, producing currents apparently running against each other. In this case the currents toward the middle of the block probably passed to the gas mains.

It was demonstrated beyond question that while the general resistance between track and pipes may be high and the current leakage small yet there are frequent points where there are paths of low resistance through the soil where the flow of current is many times above the normal. It was a singular thing that such points seemed to be as frequent and the flow of current apparently as strong along the well-built and bonded Mission road as along the very poor S. F. & S. M. road.

Some points were found where the leakage was so great that by watching the drop of potential over 100′ of water pipe all the movements of the car controller could be noted when a car started near the leakage point.

In the regions where the pipe was + to the track many similar points were noted, but of course the readings were the reverse of those found where track was +. If there was a path of low resistance at a street crossing the current would flow toward that point from all directions, while such a point in the middle of a block would be denoted by current flowing toward the middle from both ends.

There is one more point of some importance to be noted which the author believes to be new, at least the fact has not been previously noted.

Along the 18th street line the water pipes stop a short distance above Castro. They do not cross the region marked Hill Park or unoccupied hills.

On Haight street just north of the Hill Park is a large main which connects with one on Castro street and the block below Castro. The largest, however, is on Castro.

Along the line of the Metropolitan road the pipes are + to track from the crossing of Baker and Oak all the way past the power house to the terminus of the road at Ninth avenue and H street. During the summer tests the Haight street cable track came neutral to the pipes at about Baker.

Far to the south it will be noted that the Mission street road and the S. F. & S. M. road come nearly together at Randall street. Along the line of the S. F. & S. M. road the ordinary cast iron service mains do not go beyond Randall toward the power house, and these pipes, as well as the gas pipes, come to dead ends at about the limits of 30th street down on the map. They run out Mission street a few blocks south of Randall, but do not cross over to the San Jose road.

On the San Jose road and passing the S. F. & S. M. power house is a 30″ wrought iron trunk main which follows the line of the electric road to Randall and Chennery streets.

There it leaves the line of the road and turns down Randall to Mission, then down Mission to Valencia, down Valencia to Market, beyond which it does not concern this pipe. On the San Jose road it is the only pipe, while on Mission or Valencia it has no connection with the ordinary cast iron pipes except as they come close together in the soil.

Now from the location of this pipe it is evident that whatever current follows the waste pipe to the S. M. power house must pass through the soil from the cast iron service mains to this pipe. It is evident that the greater transfer will take place toward the terminals of the cast iron pipe, and it may be expected that the current will concentrate in the cast iron pipes near Valencia. In fact it does so accumulate, and this accounts for the heavy current in the Mission street pipe, during the summer, in virtue of which these pipes were + to that track before the Mission road was put in operation. It also accounts for the + condition of the pipe relatively to the Valencia cable track for a street distance near 26th street. Probably at that point there is a low resistance path between the cast iron service mains and the wrought iron trunk main, with the result that there is a heavy concentration of current in the cast iron pipes at that point. This shows that a careful study of the pipe lines is sometimes necessary in order to understand some peculiarities that may be found.

All along Mission street from the water front to about Fourth street the current in the pipes was found to set toward Market street as might be expected. From about Fourth street out to about Ninth it was noted with surprise that there was a heavy set of current from Market toward Mission. It was supposed the current which had passed to Market street pipes lower down town was returning to the Mission pipes in order to reach the power house, but the puzzling fact was that the volume returning seemed to be very much greater than that which had gone to Market street.

From about Fourth to Seventh or Eighth the current continued across Mission street toward Howard, across Howard toward Fulsom and Harrison. Beyond Eighth it apparently followed partly out Mission and partly around to Howard.

It was not known at that time that the Brannan street track was bonded and connected to the dynamo and acted as a return, with the consequent formation of a region when the pipes were + to track, but when testing along Harrison and Bryant it was found that the current in the pipes was not following the line of the S. M. road, but was setting strongly to the south, and upon following up this current it was discovered that Brannan street was used as above for a return.

When testing on 14th street, between Mission and Guerrero, it was found there was a heavy set of current in the pipes down 14th street, and on Guerrero, from 14th to 24th, it was found that the current constantly set heavily toward Valencia street, and upon testing at Valencia it was found that this current was crossing and going to Mission street. On Mission street the general direction of current was toward 16th from both sides, as was natural, since that was the point where the return wires to the dynamos connected with the track. There was some variation of current direction, owing to natural paths of low resistance from pipes to track, but, in general, the current was toward 16th. As soon as the limit of + condition of pipes was reached at 24th street, however, the current

in the Mission street pipes no longer set toward the Mission street power house, but passed up to Valencia, the current from Guerrero also coming to the same street. Up Mission, beyond the junction with Valencia, the current in the cast-iron pipes was up Mission toward Randall, and this current direction continued until Randall was reached. As soon, however, as Randall was passed the current in the Mission street pipes reversed towards Randall from the other direction. The reason is obvious, because the great trunk main passing the S. F. &. S. M. power house turns from Randall into Mission, and the current flowing from Mission toward Randall shows a transfer of current from the cast to the trunk pipe, but the current coming down to Randall from the south can only be leakage current from the Mission track, as there is no other road located where it would be possible for current to reach these pipes.

This current must be the leakage to pipes in about four blocks, as the pipes extend no further than that on Mission beyond Randall.

Up the 18th street line there is a heavy set of current in the Castro street pipes around the Hill Park to Haight street, and out Haight street toward the west. So much so that whereas in the Summer the pipes were + to Haight street track only as far as Baker, now they are + way down to Steiner.

When testing on the lower Metropolitan line a heavy set of current was found going down to Market and across Market, thus explaining the set of current previously found from Market toward Mission.

These various facts can now be connected together. The different power houses are so located with reference to each other that the lower Metropolitan line is nearer the Mission power house than it is to the Metropolitan, and the current which leaks to the pipes passes to the Market street company's power house. The same is true of a considerable portion of the current which leaks to the pipes from the S. F. &. S. M. tracks as far south as 24th street. On upper 18th street the current goes around the hill to Haight street and so to the Metropolitan power house in sufficient quantity to balance the current which went from the lower part of the Metropolitan road to the Market street company's power house. Finally, the current which goes from the S. F. & S. M. road to the Market street company's power house is balanced by current from the Mission road going up Randall in the big main and so to the S. M. power house.

In general it may be said that when several power houses are located in a city within the limits of a network of ground conductors which is everywhere practically continuous, the current which passes to the continuous conductor from the several roads will distribute itself between the different power houses in such a manner that the resultant return circuit for each road is the shortest possible without reference to the dynamos from which the current came. Of course, each station must take back as much current as it sends out.

This being true it would evidently be advantageous for different roads to wire their tracks together at properly determined points, as each could thus make a very considerable virtual reduction in the length of the ground circuit.

It would manifestly be to the advantage of all roads to wire the Metropolitan to the Mission where they come close together at Fifth street, to wire the Market street company's road and the S. M. road together where they cross at 14th and 29th streets, and carry a wire across connecting the tracks at Randall street. Finally, the S. M. road should be wired to the Metropolitan where they come close together beyond the Hill Park.

The Metropolitan road has come into the hands of the Market street company, and is to be remodeled, and the power house removed, so these conditions will be changed.

The conclusions to which these tests lead are that everywhere along the line of an electric road where the track is + to the pipes there is leakage to them. This is generally small in amount in most places, but the sum total of all the leakage currents along the line of a road of any considerable extent will be of very large amount, and there is no practical system of surface road construction adequate to prevent such leakage.

Although the leakage is generally small at most points, yet at frequent intervals there are paths of comparatively low resistance through the soil, and at such places the leakage is very much above the normal.

Where the wires from the negative of the dynamos are connected to the track the potential of the track is lowered, with the result that throughout a region of greater or less extent, depending upon the circumstances, the pipes will be + to the track. All the current which leaks to the pipes when the track is + must flow to these regions where the pipes are +, and as they are relatively of small extent the volume of current in the pipes may become very great.

This current must return to the dynamos, and to do so must pass through the ground to the track, and in so doing will produce corrosion of the pipes. This corrosion would be very slow and distributed in proportion to the potential difference between pipes and rail at various points if the resistance between pipes and track was everywhere the same; but, as above noted, the experiments demonstrate the frequent location of paths of resistance much below the normal, and at such places the flow of current, and consequent corrosion, will be much greater than the average. In fact, the existence of such places will protect the neighboring pipes by drawing away current that otherwise would pass everywhere.

Throughout the entire region where pipes are + such points will be found where corrosion is steadily going on, and while it might not be manifested by the giving way of the pipes within three or four or more years, yet when they did begin to give way they would be found to be so weakened in many places that the application of the pressure after one place was repaired would probably cause other places to give way.

Corrosion is much less than sensational newspaper articles would lead one to suppose, but it is steadily going on, and may be expected eventually to cause much trouble unless means are adopted to prevent it.

Probably it can never be entirely overcome, but it can be so far minimized as to be practically removed as a source of serious danger.

As a protection it was recommended that at frequent intervals (say at every street crossing) throughout the region where the pipes are + to track, the pipes and track be wired together by a No. 0 wire (or more than one if necessary), care being taken to make good and permanent metallic contact by the wire with both pipe and track. These wires will be metallic paths of such low resistance between the track and pipes that the current will return by them instead of through the soil, and hence corrosion be prevented. This is the simplest and cheapest remedy that can be adopted, and in the author's opinion is the only practical method of overcoming the danger with the present method of operating the cars. Any complicated and expensive special conductors running from the station into the danger region and there connecting with the pipes is entirely unnecessary. With pipes as ordinarily located with reference to a station, it is not considered advisable to wire very heavily at a point near the power house, as this would cause a final concentration of all the current in one pipe, and while the pipe might be protected as far as the track is concerned, bad corrosion might be expected at the joints. The method of distributed wiring is much to be preferred.

Wires should be put in until the pipes and track are neutralized throughout the region where the pipes tend to be + to track. By beginning the wiring near the centre of the region and wiring toward the ends it will be found that the region will undergo considerable contraction, thus diminishing the necessary number wired points.

Potential readings do not in themselves mean anything unless the resistance is known, but when the extreme sensitiveness of the pipe joints to current is taken into consideration it will be found that a Weston voltmeter is not only sufficient for the obtaining of data regarding potential relations, but by means of it points where there is any appreciable amount of leakage either to or from pipes can generally be closely located and even the condition of the track bonds be fairly well determined.

The San Francisco and San Mateo track was — to the 30″ trunk main from the junction of Randall and Chennery to far south of the power house. A spur from the power house joins the main road at Sunnyside avenue, as shown, and at that point the pipes averaged 6½ volts + to the track. This point was wired to track, and in the middle of the day the current passing over these wires was between 250 and 300 amperes. At that time the station output was but 400 amperes (average), thus showing that more than half the total output of the station was being returned through the pipes. Wires were put in at various points until the pipes and track were practically neutral, and all danger removed.

Putting in these wires not only removed the danger of corrosion of the pipes, but by returning current to the station through a very low resistance diminished by a very considerable amount the power required to drive the current out of the pipes, thus reducing the coal bill.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—The object of this department is to give a digest of the principal technical articles on electrical subjects appearing in American and foreign periodicals. The abstracts will contain, briefly, the nature of the article, its object, and the most important data or conclusions, as far as the limited space will admit. Abstracts made by the authors, editors, or publishers are solicited and should be sent to the Philadelphia office of THE ELECTRICAL WORLD, 927 Chestnut street. They should be forwarded so as to be received at least as early as the journal in which the original articles appear; they should not be longer than the importance of the subject warrants, and must comply with the general outline given above, the compiler reserving the right to edit or reject them. Such abstracts may be sent in the English, French, or German languages. It will be to the advantage of all concerned if editors of non-electrical journals, or of such electrical journals as are not regularly abstracted, will send the compiler a copy, specially marked, in which any important electrical article appears.

Note.—Through the kindness of Mr. Katogi, the editor of the "Electrical Friend," the only electrical paper (monthly) published in Japan, the Digest will hereafter include data and other matter of interest to Americans which appears in that journal.

DYNAMOS, MOTORS AND TRANSFORMERS.

Compensating Coils for Armature Reaction.—Mr. Menges in the Lond. "Elec.," March 22, in referring to the recent paper of Mr. Sayers (see Digest, March 16, 23, 30), calls attention to the British patent of Edison, No. 5,127, 1883, which he says relates to substantially the same device as that of Mr. Sayers. He, Menges, subsequently invented another device for the same purpose, which was preferable, and which, in the discussion, was attributed to Mr. Swinburne; his patent has expired. Extracts of the Edison patent, with illustrations, are published in that journal.

Niagara Dynamos.—Prof. Forbes, in the Lond. "Elec. Rev.," March 22, in reply to Mr. Brown (see Digest last week) states that the alternator to which he referred has a stationary armature between two revolving fields which fails to secure the advantages he sought for; he claims that most of the points mentioned by Mr. Brown are not adopted in the Niagara dynamos.

Niagara Dynamos.—The recent communication of Mr. Brown, mentioned in the Digest last week, is reprinted in the "Elec. Eng.," April 3, together with illustrations of the Forbes design and that adopted.

Tesla's Oscillator.—See "Tesla's Inventions" under Electrophysics.

LIGHTS AND LIGHTING.

Electric Lamps in Coal Mines.—An experiment of Dr. Haldane is recorded in the Lond. "Elec.," March 22. He entered a mine containing large quantities of "black-damp" with an electric lamp, and proved that there is a wide margin between the point of extinction of a candle or lamp and the point of danger to life; a miner could with impunity penetrate atmospheres containing three times as much black-damp as would extinguish a lamp, and the difficulty of respiration would give ample warning if the electric lamp did not; electric lamps ought therefore to be very useful for inspectors.

Possible Rival of Electricity for Illumination.—The "West. El.," April 6, contains an article by Mr. Haskins on this subject, in which he gives the properties of calcic carbide and acetylene (all of which have been fully reported in these columns); regarding the possible competition with the electric light he merely states in closing "whether acetylene will some time rival electricity as an illuminant is yet to be seen."

Tesla's Lighting Effects.—See "Tesla's Inventions" under Electrophysics.

Decorative Lighting.—Some decorative electroliers are reproduced from "Ornamental Iron," in "El'ty," April 3.

POWER AND HEAT.

Annealing Wires.—The Diesler process is described and illustrated in the "Elek. Echo," March 9 and 16; it is for use chiefly in connection with wire drawing in order to soften the wire without the production of the scale produced by the usual method, which involves also a subsequent pickling and cleaning. The Legrange & Hoho process (which has been fully described in these columns, and is known in this country as the Water Pail Forge process) is made use of. The wire passes continuously over rollers through a suitable liquid such as a salt solution, and thence up through oil or some similar liquid for cooling it; a current is passed through the wire into the electrolyte and thence to a suitable electrode the action of which is to heat the wire in contact with the liquid; passing it through the oil subsequently cools it sufficiently so as to prevent scaling, the wire therefore remains perfectly bright; the extent of the annealing is regulated by the speed with which the wire is drawn through the solution; it is claimed to be a perfectly practical method and is thought to be economical also.

Electric Riveting Machine.—An electric riveting machine and its application in the construction of bridges is described and illustrated in "L'Industrie," Feb. 3; an electric motor is used to drive a pump for operating the hydraulic riveting machine, the whole apparatus being quite portable.

Mining Machinery.—In a description of a plant in a mine at Prague, in the "Zeit. f. Elect. u. Electrochem.," March 15, several illustrations are given, one of a movable pump and another of a windlass.

Electricity in Agriculture.—A recent paper by Mr. Brutschke is abstracted in the "Zeit. fuer Elek.," March 15.

Transmission Plant.—An installation for about 53 kw is described and illustrated in "L'Elec.," March 23; the plant runs several saws, a pump and a large ventilator; a table of data is given of the power required by each of the machines.

Installation at a Copper Mine.—According to a description of the Ashio mine plant in the "Elec. Friend" (Japan) for February, 1,419 hp are used in 14 generators, nearly all of which are driven by water power; the energy is used for driving 17 motors, 1,600 incandescent lamps and 40 arc lamps.

Electric Motor in a Boiler Shop.—A brief illustrated description of a motor installation in a boiler shop is given in the "Am. Eng." for April in which also the recent letter of Mr. Melotte (see Digest, March 16) is published in full.

TRACTION.

The Use of One or More Motors on Cars and Locomotives.—In an article by Mr. Hoho published in "L'Eclairage Elec.," March 2, he discusses in detail the action of two motors on the same car, connected in series, in parallel and excited in various ways; he discusses it with reference to the traction resistance and the resistance against slipping, and concludes that the use of two or more electric motors on the same car or train involves serious objections from the point of view of slipping or skidding; there are cases, however, where the conditions, such as the dimensions of the motors and other considerations, make it necessary to sub-divide the motor, and in that case there is no doubt that coupling them in parallel is better than in series: it is necessary to take all possible precautions in dividing the load on the axles to avoid partial slipping.

Relative Costs of Operating Motor Cars and Trailers.—In a discussion of the subject in the "Zeit. f. Elect. u. Electrochem.," March 15, the costs of running the cars are divided into several different classes, and the relative costs for motor cars and trailers are then readily determined under each of the headings.

Mechanical Power on Tramways.—In a brief article by Mr. Dawson in the Lond. "Elec. Rev.," March 22, he gives some figures regarding the cost of cable and electric traction, etc., based on various American roads.

Determining the Traction Effort of Locomotives.—A new method is described by Mr. Ferron in "Cosmos," Feb. 9.

Statistics.—The statistics regarding electric railways in Europe, given in abstract in the Digest last week, are given somewhat more fully in the Lond. "Elec. Eng.," March 22.

Kioto Railway.—According to the "Elec. Friend" (Japan) for February the first commercial electric railway in Japan was temporarily opened on Feb. 1 with four motor cars upon four miles of road; the road will soon be seven miles long, extending from Kioto to Fuskimi; the power is obtained from waterfalls and the apparatus is all of American manufacture.

Surface Contact Road.—An illustrated description of the road in Lyons in which a surface contact system is used (see Digest, Oct. 13 and 20), is published in "La Nature," March 2.

Electric Carriage.—The Pouchain carriage is fully illustrated with details, and described in "Cosmos," Feb. 16; the results obtained are claimed to be remarkable: the following data are given: there are four boxes of 13 accumulators each; they are contained in a box of aluminium lined with celluloid; the solution is made of three volumes of sulphuric acid at 30 degrees and one volume of silicate of soda at 18 degrees, making a gelatinous substance; the capacity is 70 ampere hours; by coupling these four sets in different ways three different speeds are contained, the fastest being 9.6 miles per hour; one charge will run 30 miles at least, depending on the road; the motor is a series wound machine of about 3.5 kw, but can be forced to 6 or 7 hp. Provision is made in the carriage for a light petroleum motor which may be used to charge the accumulators during a trip, by which means the distance may be doubled; the carriage weighs about 2,800 pounds, made up as follows:

accumulators 1,100, dynamo 242, accessories 66, body of the carriage 1,390.

Boat Traction.—The French journal the "Rev. Industrielle," March 9, contains a long description of the de Bovet system, which is in use in France, and in which the boats are drawn by means of an anchored chain, the friction of which against the drum being produced by a magnet; the article contains a large double page plate of drawings of the details. The system has been described in these columns.

Compressed Air Traction.—An article by Mr. Saintive giving a description, including data, of the systems used in Paris, is contained in "Cosmos," Feb. 23.

Legal Aspects of Electrolysis.—"Cassier's Mag." for April contains an article by Mr. Townsend. He considers it a well settled fact that serious damage is being done to gas and water pipes and believes that the success of the remedies proposed is somwehat doubtful as long as the rails employed form part of the circuit. He discusses the question as to the responsibility of the injuries and compares it with a similar question which arose a few years ago in the controversy between the telephone and the electric railway companies the majority of which decided in favor of the latter; the value of these precedents, however, is open to grave doubt; he points out the differences and cites other cases of a more similar nature. The damage by electrolysis cannot be said to be unavoidable because there is a plain remedy in the use of the double trolley, the use of which is not inconsistent with the full enjoyment of all the advantages to the public from electric transportation; although the courts may dismiss the claim of the telephone company for damages arising from joint occupancy of the streets because the injury in that case is the result of an attempt to use that which each has a right to, no such disposition would answer fully any claim which the owner of an abutting lot might make for damage to his easement in the street for the purpose of water and gas pipe connection because, on principle, that use stands practically upon the same footing as his right to secure light and air from the street. A remedy exists in the form of a double trolley and there is sufficiently reasonable expectation of relief from the expedients which are now being proposed to free the railway companies from the charge of negligence; these remedies will probably so diminish the evil that it will become difficult to place the liability or to say with certainty what the corrosion hereafter observed is attributable to, that is whether to the trolley current or to the direct corroding influence of the earth and its constituents.

Corrosion of Underground Pipes in Brooklyn.—The "Elec. Age," March 30, reproduces some of the illustrations from the report of the Board of Commissioners of Electrical Subways in Brooklyn.

Three-wire System.—In the Knight system briefly described and illustrated in the "Elec. Eng.," April 3, the objections to the difficulty in balancing are intended to be overcome by crossing over the trolley wires of the different tracks at specially located points so that cars on the same track will take currents from different sides of the neutral wire.

Conduit Railway in New York.—According to the "St. Ry. Jour." for April a section of about a mile and a half of Love conduit will shortly be laid in New York City.

Rapid Transit in Large Cities.—Part of a recent discussion at a meeting of the New York Mechanical Engineers is reprinted in the "Am. Eng." for April; most of it refers to steam roads. Mr. Parsons expressed the belief that the day had already come when electricity as a motive power is more economical than steam; he gives the following figures representing the coal consumed in pounds per ton per mile on the different elevated roads as obtained from the officers of those roads: Liverpool .416, Intramural .495, City & South London .604, Ninth Avenue Manhattan Road, short trains .609, Brooklyn elevated, short trains .661, Manhattan, large trains .928, Brooklyn, large trains .526; he claims that it is unfair to take into account the Manhattan figures. For the electric roads the consumption of coal in pounds per ton per mile is about two-thirds that for steam roads; on the Liverpool line a cheap grade slack is used while on the Brooklyn road they burn a high priced anthracite; if therefore the comparison is made in dollars the difference would be far greater than when expressed in pounds.

Economical Equipment of Power Stations.—In an article by Prof. Carpenter in "Cassier's Mag." for April, he discusses that portion of the equipment of power stations for electric railways which belongs particularly to the province of a mechanical engineer; a number of illustrations of the Ithaca plant are given, also a table of the probable water consumption per indicated and per delivered horse power per hour for various classes of engines with different loads; another table gives the cost per horse power for a plant of 500 hp with different kinds of engines; another, the yearly cost per 100-hp including fixed charges and fuel for various classes of engines.

The Successor of the Railway.—An article with this title by Mr. Morgan is published in the "Pop. Sc. Mo." He discusses the trolley system with special reference to its effects on steam roads; also such questions as that of eminent domain, cheapness, etc. This newcomer "seems equipped with every opportunity that the railways have been coveting for 50 years and to be getting for the asking everything for which the railways have to pay the heaviest;" it "is actually and practically solving those social and agrarian problems which within a few years had threatened serious upheaval of the body politic;" "who shall guess whether the 20th century trolley company will not be as remorseless a tyrant as the poor superseded railway company was alleged to have been in its days of dominant usefulness and prosperity?"

Rights of Suburban Electric Railways.—The important decision of the Supreme Court of Pennsylvania against electric railways, regarding the right of eminent domain, is reprinted in the "St. Ry. Gaz.," March 30.

Connecticut Electric Railways.—An address by Judge Gager on behalf of the electric railways of the State, forming a reply to are cent address of Mr. Hall, is reprinted in the "St. Ry. Gaz.," March 30.

Street Railway System of Boston.—A long and complete article, illustrated with about 50 cuts, is published in the "St. Ry. Jour." for April, describing the construction and operation.

Lynn & Boston Line.—An illustrated description is published in the "St. Ry. Jour." for April.

Minneapolis-St. Paul.—The anuual report is abstracted in the "St. Ry. Jour." for April.

Repair Shops.—The "St. Ry. Jour." for April contains an article by Mr. Merriam describing the design and equipment of a railway repair shop, including illustrations of the building and the tools.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Electric Lighting Companies in Japan.—According to the "Elec. Friend" (Japan) for January, the dividends for the last six months of the preceding year declared by the companies are as follows: Tokio (steam) 7.5 per cent., Kioto (water-power) 15 per cent., Osaka (steam) 12 per cent.

Train Lighting.—Some details of the systems used in Denmark are illustrated and described by Mr. Bruun in the Elek. Zeit.," March 14.

Amortization.—The discussion of the subject is continued in the "Elek. Zeit.," March 14, by a communication from Mr. Pruecker.

Storage Battery Plant.—A private residence plant of a capacity of about 300 lamps and a few motors, the current being supplied from a distant station, is described and illustrated in the "West. El.," April 6.

Electric Lightship at Sandy Hook.—A brief illustrated description is published in the "Elec. Age," March 30.

WIRES, WIRING AND CONDUITS.

Sodium in Conduits.—Mr. Wright in the Lond. "Elec.," March 22, calls attention to a compound which he found on underground wires and which, several days after its removal, gave brilliant but minute flashes of light by drawing the finger over it; he suggests that it might have been sodium or potassium.

Mr. Voysey in the Lond. "Elec. Rev.," March 22, in reply to a recent editorial in that journal states that the energy with which sodium decomposes water produces sufficient heat to ignite the escaping hydrogen if the sodium is prevented from darting about on the surface of a sufficient quantity of water to cool it; metallic sodium as found in conduits could therefore produce ignition.

Grounded Neutral Wire.—To decide whether permission should be given in a certain city to grounding the neutral wire of a three-wire system, the question was submitted to the leading electrical society of Germany, whose report was favorable; the whole report signed by Messrs. Kapp and Slaby is published in the "Elek. Zeit.," March 14.

ELECTRO-PHYSICS AND MAGNETISM.

Duration of Lightning Flashes.—"La Nature," March 2, contains a short article by Mr. Guillaume in which he discusses the duration of an electric discharge. A spark produced suddenly is brilliant during a very short interval but fades away gradually, its total duration is very variable, depending upon circumstances under which it is produced; ordinarily the very luminous period extends over several hundred thousandths of a second, but Hertz has shown that the duration of the phenomena is so short that one has not been able to determine it; it is, however, much less than a hundred millionth of a second; a lightning discharge often seems longer but it is easy to be deceived in this. Photography as ordinarily applied does not prove anything regarding the succession of sparks from the same causes which it is reasonable to believe exist, as the air heated by the first discharge becomes a good conductor and offers a good path for a second spark; an impression of a light of short duration has been shown to be followed by a sensation of darkness, then by one of light and again by one of darkness, but a simple observation is not sufficient to prove the succession of discharges. Several photographs of lighting discharges are reproduced, one by Weber in which the camera was simply rotated by hand so as to describe the surface of a cone; it shows two parallel jagged lines connected by striations, some of which form complete eclipses between the two lines; another photograph shows a multiple discharge; in another by Mr. Trouvelot the camera was given a jerking motion in a horizontal plane, the image therefore showed numerous parallel jagged lines of different widths and shows either that the duration of the discharge was sufficiently long or that it was composed of numerous discharges in exactly the same path.

Electric Currents of High Pressure and Periodicity.—A paper by Mr. Swinton is reprinted with some of the illustrations of the apparatus in the Lond. "Elec. Eng.," March 22. He discusses the action of such currents and shows a number of well-known experiments, the currents used being those from the disruptive discharges of Leyden jars. He estimates that the duration of the discharge of the jars which he used was about one 50 thousandths of a second and the rate of oscillation

about 200,000 complete periods per second, making about four complete oscillations for each discharge; the jars were charged with an alternating current; he calls attention to the relatively long period of rest between the discharges and criticises the term "high frequence" as applied to such currents because, although the periodicity is decidedly high during each discharge, the time of discharge is so short that the comparatively long intervals make the average frequence really not high at all; he furthermore believes that high frequence is not at all necessary to explain the effects produced (which effects are mainly those shown by Tesla), all that is necessary being impulses of exceedingly short duration. He describes a number of well-known experiments and discusses at some length the heating of an incandescent lamp filament by exceedingly small currents of this kind.

Transmission of Electricity through a Gas Surrounding a Conductor.—The paper of Messrs. Vicentini and Cinelli, abstracted, in the Digest March 2, is abstracted at some length in "L'Eclairage Elec.," March 2.

Resistance and the Discharge in a Mixture of Nitrogen and Hydrogen.—An abstract of the paper of Miss Fawcett from the "Proc. Roy. Soc.," vol. 56., p. 263, is published in "L'Eclairage Elec.," March 2.

Waves and Vibrations.—An abstract of the second lecture of Lord Rayleigh is given in the Lond. "Elec.," March 22.

Magnetic Rotary Dispersion.—A recent paper by Mr. Siertsema is abstracted briefly in the "Rev. Gen. Des. Sciences," Feb. 28; some curves and formulas are given showing the relation between the length of the wave and the rotation, for nitrogen, oxygen and air.

Electric Origin of Earthquakes.—The question whether earthquakes are due to violent electric currents between the earth's crust and the atmosphere is discussed in "L'Elec.," March 23; the theory was offered by Mr. Offern and was favored by Plante; it is believed that earthquakes are merely superficial.

Tesla's Inventions.—The "Century Mag." for April contains a long well illustrated article on "Tesla's Oscillator and Other Inventions" by Mr. Martin; it is written in a popular style describing the oscillator and a number of light effects, which latter are well illustrated, some of them by means of photographs made by their own light; among the light effects are those of the incandescence of a solid, phosphorescence, incandescence or phosphorescence of a rarefied gas and luminosity produced in a gas at ordinary pressure. He describes also effects with widely separated resonating circuits in one of which it is claimed that at least one-tenth of a horse power was transmitted across a space of some 20 feet into the bulb of a lamp without using any wires at all; other experiments show how lamps were lighted by currents passed through the human body; an experiment is described showing the disturbance of the earth's electrical charge.

Some other illustrations of the oscillators are reproduced with a brief description in the "Elec. Eng." and "Elec. Rev.," April 3, and one of them in "El'ty," April 3. In the former it is stated that the principle involved in the oscillator is that of "oscillating a coil or magnet with great economy of energy in an intense field and thus generating current on terms of very high efficiency and regularity as well as with marked diminution in size and weight of apparatus. The engine resolves itself down to a chest or cylinder for the working fluid and the piston for carrying the armature." There is a strong air spring in the top of the apparatus and the construction is such "that the engine is always in exact synchronism with the vibrations of this spring;" the engine varies the amplitude of the vibration but the period remains always the same; "the recoil of the spring is of course incomparably greater than the impulse received by it from the engine." Several distinct types are shown and briefly described, that of the more advanced form being as follows: "this minute machine had a capacity of 12 lights. It consisted of a small oscillator and a dynamo, the latter comprising a field magnet with its exciting coils and an armature merely of iron. The magnet had on its inside a number of pole projections upon which the induced coils were wound. The armature had projections of lesser number than those of the field. In this way the output of the dynamo was increased, by the number of teeth." It is stated that there is a preponderance of one impulse over the other creating virtually the effect of a direct or continuous current, but this is not described. With the latest form of oscillator which is illustrated, the frequency is 80 to 100 and the steam pressure 350 pounds, the steam admission being controlled by a small independent oscillator. In conclusion it is stated that "there can be no doubt that in this appliance we have a mechanism for the simultaneous utilization of steam and generation of current under conditions that must effect large economies in every direction; while it should also prove a powerful instrument for exhaustive research."

Velocity of Electric Waves.—A paper by Prof. Trowbridge and Mr. Duane is published in the "Am. Jour. of Sc." for April. Some time ago they suggested the following method of measurement: the size of a Hertz vibrator is increased and if necessary the shape changed until the period of oscillation is sufficiently long to be determined by photographing the spark; the length of the induced waves in a secondary circuit tuned to resonance with the vibrator is then measured and the quotient of the wave length by the time of a complete oscillation will be the required velocity. They arranged the apparatus so that the reaction should be wholly electrostatic; the method, which is described in detail, proved to be very successful; the average result is 2.816 multiplied by 10 to the tenth power; in the generally accepted value for the velocity of light, the constant is 2.998; they do not think it likely that the error in their determination is as great as the difference between the two values; their experiments are to be carried out more carefully.

Double Refraction of Electric Waves.—A paper by Mr. Mack from the "Ann. d. Physik. u. Chemie.," No. 2, p. 342, is abstracted briefly in the "Am. Jour. of Sc." for April. He found that by interposing pieces of wood between Hertz's well-known parabolic reflectors, the axes being inclined to each other, the electric waves can be doubly refracted; wood has a different structure along the direction of the fibres from that perpendicular to this direction, it is thus analogous to doubly refracting crystals. The same paper is abstracted briefly in the "Elec. Eng.," April 3.

Production of Kathode Rays.—A translation of the abstract of Mr. de Kowalski's paper (see Digest, March 23) is given in "Elec. Eng.," April 3.

ELECTRO-CHEMISTRY AND BATTERIES.

Electrolysis of Gold.—Mr. Keith's paper (abstracted in the Digest last week) is published in full with the illustration in the Lond. "Elec.," March 22. In the discussion which followed Mr. Vautin stated that Dr. Gore in the "Philosophical Transactions" in 1860 proved that mercury is electronegative to gold in a solution of cyanide of potassium and that Mr. Skene some time ago pointed out that gold was so electro-positive to mercury that it was dangerous to allow them to come in contact, as the gold was dissolved and the mercury was not; the same process had been used in a mine in Hungary for two years; experiments were carried out there with and without the mercuric cyanide and the results were in favor of mercury cyanide alone; of all the methods suggested he thought none were better than the practice of simply using zinc; if there is any free alkali present there is a great risk of forming alkaline sulphides. Mr. Swinburn favored going back to the simple process of using zinc shavings without all the complications of the electric process and he does not think that electrolysis is going to do much good in the recovery of gold. Mr. Crompton asked whether there was not considerable difficulty in keeping the porous pots in order, as such pots had given considerable trouble in an important copper process; he suggested that the results of a more quantitied character would not have been acceptable. Mr. Keith stated that he had never passed as much as 100 tons through the process, but he had used it to a sufficient extent to satisfy himself that the process was practicable; in the zinc process he believed that about 50 times as much zinc was used as was necessary; there was no difficulty in the use of porous pots. The subject is also discussed in the leading editorial in that journal, which however contains nothing new.

Mr. Andreoli in the Lond. "Elec. Rev.," March 22, remarked that Faraday would have been horrified if he had heard this paper read; he believes that there are some people who are ready to upset the elaborate equations and theories regarding the statement that the presence of oxygen is necessary for dissolving the gold; he believes that there is nothing particularly original in this mode of electro-deposition, and although its merits and advantages are exaggerated, it is no doubt far superior to and cheaper than the Siemens process, which is neither very good nor new; he suggests that there is nothing about the electrolysis of gold solutions in the paper. Mr. Fitzgerald in an article in the same journal also discusses the subject. He considers the paper open to objections and discussion; he discusses the question why such a poor solvent as cyanide of potassium is ever used when so powerful a solvent as chlorine is so readily available, the explanation of which is that gold in chloride solutions is electro-negative to almost every other metal; he also discusses the question whether potassium cyanate and not potassium cyanide is the real solvent of gold and doubts whether it is necessary to convert any cyanide into cyanate in order to promote the solvent action; other analogous questions are discussed.

Diaphragm of Soap.—According to "Cosmos," March 9, Mr. Kellner of Austria has patented the use of a diaphragm of soap for use in electrolysis. In separating substances by a diaphragm those which have an affinity for the material of the diaphragm traverse it more rapidly; in electrolyzing a solution of salt if the salt is placed in the anode portion and is forced to diffuse through the diaphragm the return diffusion of the caustic soda from the cathode portion is prevented almost completely; the phenomena can be explained by a sort of chemical repulsion between the soap and the salt solution or by a special affinity of the soap and the alkaline caustic; it is best to make the soap of the same alkali as that contained in the salt.

Electrolysis of Fused Salt.—The article of Mr. Andreoli is continued in "L'Elec.," March 23; the historical summary is continued; a table is reprinted from a paper by Mr. Braun giving the conductivity and other data of a number of fused salts, as also the fusing temperatures of the metals.

Cells with Fused Electrolytes.—An abstract of Mr. Swan's paper from the "Proc. Roy. Soc.," vol. 56, p. 56, is published with illustrations in "L'Eclairage Elec.," March 2.

Resistance of Electrolytes.—The "Lond. Elec. Rev.," March 22, calls attention to an article by Prof. Kohlrausch in the "Zeit. Phys. Chem.," 15, p.126, in which he justifies the use of his well-known method of determining the resistance of electrolytes; he believes that the telephone method with alternating currents can be used for much higher resistances than those examined by Mr. Wildermann and is more convenient.

Electrochemical Analysis.—The Lond. "Elec. Rev.," March 22, recommends a paper by Mr. Bortmann in the "Monatshefte fuer Chemie," 15, p. 280, in which he describes the method of estimating the halogens

electrolytically. Also a paper by Mr. Oettel in the "Zeit. f. Elec. u. Elektrochem.," 6, p. 192, in which he describes the electrolytic determination of nickel and cobalt.

Plating with Cadmium Silver.—The Cowper-Coles process is described briefly in "La Nature," March 2; the bath is made of a solution of the double cyanide of cadmium and potassium and the anode of the alloy of cadmium and silver, containing say 7.5 per cent. of cadmium; the cadmium hardens the silver.

Electric Tanning.—The Lond. "Elec. Rev.," March 22, recommends very highly (but does not abstract) a paper by Mr. Groth in the "Scottish Leather Trader" (no date given); the paper was read quite recently and shows the superiority of the Groth system. (According to a recent statement in a German journal the use of this system in a large installation in Switzerland was abandoned as it was too expensive.)

UNITS, MEASUREMENTS AND INSTRUMENTS.

Mean Spherical Intensity of Sources of Light.—An article of some length by Mr. Blondel is begun in "L'Eclairage Elec.," March 2. He defines luminous flux and discusses the formula for it; he describes an apparatus for measuring the intensity of a light in different directions in a vertical plane; all those in which mirrors are used at different inclinations combined with the displacement of the source of light are open to criticism: in the method which he describes, first suggested by von Hefner Alteneck, these objections are overcome; an illustration is given, the light itself remains fixed and its direct rays are intercepted by an opaque screen between it and the photometer; an inclined mirror is arranged so as to make a fixed angle with an axis drawn from the light to the photometer, this mirror being then revolved around this axis, thus reflecting the light emitted in various angles in a vertical plane into the photometer, the inclination of the mirror with respect to the beams of light, and the distance from the light to the photometer being thereby always maintained constant; this latter distance should be comparatively great, the loss in the mirror can be measured by replacing the lamp with a standard candle. This method has given very good results in practice and is the one at present used at the Central Laboratory in Paris. He discusses the objections to this method, one of which is the large number of measurements which must be taken and it is not sufficiently accurate, the errors being about 20 per cent.; he promises a description of another method which is more accurate.

Measuring the Figures of Merit of Telephone Annunciators.—An article by Dr. Tobler in the "Jour. Teleg.," Feb. 25, describes a simple method for comparing annunciators, and contains the results of some comparative tests. The figure of merit is usually given for continuous currents but he believes it should also be obtained for alternating currents; the difficulty in the way of such measurements is that an alternating current ampere meter for such small currents is a very expensive instrument; he therefore used a Froment motor driven by four Leclanché cells giving 3.6 volts and 0.6 amperes, which was made to operate an interrupter connecting the testing circuit alternately with the two ends of a series of cells, the middle point of which was connected to the other end of the circuit, thus generating an alternating current from a battery; a continuous current milliampere meter is inserted in one branch of the battery circuit and an equivalent resistance in the other, the ampere meter therefore measures one half of the current. The results seem to show the superiority of the annunciator made by the Western Electric Manufacturing Company.

Induction in Cables.—A paper by Dr. Breisig is begun in the "Elek Zeit.," March 14; in the present portion he describes measurements which were made with coils of double wires.

Heating of Wires.—A paper by Dr. Muellendorf on safety fuses is reprinted in the "Zeit. fuer Elek.," March 1 and 15; it appears to deal almost entirely with the heating of wires and contains a number of simple formulas.

Galvanometer.—The Sullivan universal galvanometer of the D'Arsonval type is described and illustrated in the Lond. "Elec. Rev.," March 22; it is claimed to be the only form of moving coil galvanometer which can be used at sea.

Harmonic Analyzer.—A Physical Society paper by Mr. Yule is abstracted briefly with an illustration and the theory, in the Lond. "Elec.," March 22; the instrument is practically the inverse of the one invented by Prof. Henrici.

Instrument for Measuring Difference in Phase.—Major Cardew's paper of the "Proc. Roy. Soc.," vol. 56, p. 250, is abstracted in "L'Eclairage Elec.," March 2.

Electrical Standards.—The specifications for the practical application of the definitions of the electrical units referred to in the Act of Congress of July 12, 1894, and which were adopted by the National Academy of Sciences Feb. 9, are published in full in the "Am. Jour. of Sc." for April, including an illustration of the standard cell.

Tests of the Guelcher Thermoelectric Battery.—A translation of the article with illustrations, abstracted in Digest, Dec. 22, is published in "Elec. Rev.," April 3.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telegraphic Newspaper Printing.—The "Zeit. fuer Elek.," March 15, describes the system of Messrs. Meray-Horvath and Roza, with which experiments are being made in the city of Graz, Austria. The system is briefly as follows: the news is received at a central station, and is transcribed by an instrument like a typewriter which prints one copy in typewritten characters and another copy in corresponding dots and dashes on the strip of silvered paper; the speed of this machine is said to be ten times as great as that of a compositor setting type by hand, and is estimated to be 200 to 300 lines per hour (presumably referring to a newspaper column); this copy is then corrected and the same corrections made on the paper band; by means of the latter it is then transmitted telegraphically by an automatic apparatus to as many receiving stations as desired, at which stations the matter is received in the same form on a band of paper; the speed of this apparatus is said to be about 500 lines per hour; these bands as received pass through another machine which automatically presses a type, corresponding to the letter of the Morse signal, into a plastic mass, into which stereotype metal is then poured forming the plates from which the paper is reprinted. It is claimed that the saving in the latter machine is 86 per cent. as compared with hand setting; the price of the latter machine is said to be about $17,500 to $25,000 while that of machines for sending the messages telegraphically is only about $850; a machine can deliver 120 lines per hour.

Automatic Telegraph Transmitter.—The Schklar system is described and illustrated in the "Zeit. fuer Elek," March 15; the transmitter has a keyboard like a typewriter, the lever for each key having make-and-break contacts corresponding to the particular letter, according to the Morse alphabet; on depressing a key the corresponding signals are sent to line automatically; the apparatus is said to be simple and practicable and insures greater accuracy in transmitting.

Telegraph Poles in Japan.—According to an article in the "Elec. Friend" (Japan) for January the number of poles belonging to the government is 272,058 for telegraph wires, and 12,633 for telephone wires; almost half of these are "bouchalized" (treated with copper solution), the average life of which in that country is about 15 years, while that of the poles not treated is 7.52 years; the poles are of cedar, which is very plentiful there.

Telegraph Instruments in Japan.—According to "Elec. Friend" (Japan) for January the number of instruments in Japan at the end of 1894 was as follows: Morse inkwriter 1,143, quadruplex 6, duplex 22, Wheatstone automatic 8, telephones 33.

Government Telephone Lines in Austria.—The complete list of the lines and number of subscribers is published in the "Elek. Zeit.," March 14.

Telephone Reminiscences.—An interesting and historical retrospect taken from a recent subject by Prof. Hughes is published in the Lond. "Elec." and "Elec. Eng.," March 22.

Telephone Rates for New York City.—The "Elec. Eng." and "Elec. Rev.," April 3, publish a table of the new rates based on the number of messages.

New York State Telephone Bill.—Some criticisms of Mr. Sterne's pamphlet are given in the "Elec. Rev.," April 3.

Automatic Block System.—The Hall system used between Philadelphia and Jenkintown is described and illustrated in "Eng. News.," April 4.

MISCELLANEOUS.

Developing Muscles by Electricity.—"Cosmos," Jan. 19, contains an article by M. Gil reprinted in full in the "Rev. Int. d'Electrotherapie" for January in reply to a short article which was reprinted in numerous American papers (copied we believe from the Digest, Aug. 4, and THE ELECTRICAL WORLD, Aug. 11, p. 122); he describes the original experiments more fully (see also THE ELECTRICAL WORLD, Nov. 24, p. 544); they were made by Dr. Debedat in Bordeaux to determine the question whether the number of muscular fibres was increased or whether the special properties of the muscular tissue were developed. Experiments were made on the left thigh muscles of six similar rabbits during their growing period; they were submitted to the action of electric currents during 20 consecutive days the treatment lasting four minutes, during which the applications were made regularly at the rate of 30 per minute; the muscles on only one side of the animal were treated, those on the other side being left normal for comparison; during the whole time the animals were confined so that they could not move. The conclusions were as follows: the action of electricity on muscular nutrition is complex; in the form of continuous currents it acts differently than to excite contraction; so far as it excites contraction its action is comparable to that of ordinary exercise, over which it has important advantages from a therapeutic standpoint; moderate muscular exercise caused by rhythmic faradic currents, representing natural exercise, produced very marked effects; excitation by rhythmic galvanic currents in the form of shocks produced a favorable action, but the action is less than that produced by faradic currents; prolonged tetanization by faradic currents produced an overworking of the muscle followed by a wasting away of the tissue; a static spark produced no permanent modification. In conclusion he states that contrary to the opinion of certain authors, these experiments show that the action of electricity is a real one; they also show what mode of electrification is best to produce muscular contraction; the results are of great importance. An extract from the paper is also published in "L'Elec.," March 2.

Calcium Carbide and Acetylene.—A recent lecture by Dr. Frank on the production of acetylene and its application in the manufacture of illuminating gas, alcohol, etc., is reprinted in the "Elek. Zeit.," March 7. In an editorial in the same issue it is claimed that the fear that this gas will become a powerful competitor of the electric light is groundless as is shown by the stock quotations of the electrical companies, when

this invention was made public; it considers that stock quotations may be relied upon as a means of prophesying; electrical companies need therefore have no fears; the use of pure acetylene for illuminating purposes meets with very important objections of which two are mentioned, it cannot be used in the same burners and the present gas works represent so much capital that they would not be rebuilt immediately for the manufacture of acetylene. In order to compete with the Welsbach company, acetylene, for the same illumination, would have to be sold for about half the price of ordinary illuminating gas, and it is hardly likely that it can be made at that price; if therefore the Welsbach light has not been able to injure the electric light, acetylene will be even less capable of doing so. It is claimed that one of the chief values of the carbide lies in the fact that it may be used as a carrier of energy.

Disintegration of Organic Tissue by High Tension Currents.—A recent paper by Dr. Parsons is abstracted briefly in the Lond. "Elec. Rev.," March 22. He describes investigations undertaken to ascertain the capabilities of electricity as a destructive agent in the treatment of malignant diseases; his experiments were conducted with high tension currents which reduced the heating and caustic action and increased the destructive action enormously; with freshly killed beef the structure was completely destroyed; with a lower pressure, muscular fibres were broken up and the destruction extended through the whole path of the current. Dr. Jones, who made similar experiments, claims that the destruction is due simply to the heat, as there is no other possible way in which the energy could expend itself on such a conductor. Dr. Horrocks believes that if it can be shown that living cells are broken up by an electric current it is conceivable that this method has a future before it; if the tissue of a tumor for instance could be broken up by electric currents one might succeed in setting up changes which would result in the absorption of the tumor or the exudation.

Electric Currents in the Living Body.—Mr. Hattatt in a communication to the Lond. "Elec. Rev.," March 22, considers that the recent lecture of Prof. Horsley (see Digest, March 23, 30), is hardly up to date. He quotes at some length from a paper by Drs. Bleyer and Weill read before the American Electrotherapeutic Association in September, 1893, which he claims should be read by all interested.

Death by Electricity.—According to the "Rev. Int. Electrotherapie" for December Dr. D'Arsonval stated that it is generally believed that alternating currents are more dangerous than continuous; it is quite the contrary, however; accidents with continuous currents are almost always fatal because of death being due to electrolytic phenomena, as the body is not a homogeneous conductor and polarizing actions are produced not only at the points of application but also at every surface separating two different tissues traversed by the current. Mr. Chaubeau in reference to resuscitation stated that there was a great difference whether the subjects were in a state of syncope or whether they were asphyxiated, in the former case resuscitation may take several hours while those in the second "at the end of a relatively very short time, which does not exceed more than several minutes, resist all efforts at resuscitation."

Electrotherapeutics.—A translation of the paper of Mr. Meylan on "Utilizing Electric Lighting Circuits in Electrotherapeutics," which was abstracted in the Digest, Dec. 1, is published in the Lond. "Elec. Rev.," March 22, with the illustrations.

Electrotherapeutics.—The French monthly "Revue Internationale d'Electrotherapie" contains numerous interesting articles on this subject which, as they pertain more directly to medical science, will not be referred to in these columns unless they are thought to be of general interest.

Extracting Metallic Particles from the Eye.—In a note in the "Rev. Int. Electrotherapie" for January Mr. Sulzer states that an electromagnet can be applied in two ways for extracting particles of iron from the eye, either by placing a strong magnet in front of the eye or if this does not suffice then by means of a pointed magnet introduced into it; with the magnets formerly used in the second method, one pole was used, directly, the other pole being held by the operator, but the attractive force is then very feeble; a much greater force may be obtained by making the magnet in the form of a horseshoe the two pointed poles coming very close together and separated by a non-magnetic metal.

Electro-Culture.—"Cosmos," March 23, abstracts briefly from "Genie Civil" the results of some experiments of Mr. Luehnenschloss with the apparatus called geomagnetifere (not described); in a potato field those plants which were treated weighed 11¼ per cent. more and the richness in starch was 23.7 to 20 7 greater; during another year the treated plants yielded 10 per cent. more potatoes in quantity and of a superior quality.

Electrical Industries.—According to Mr. Shoolbred the amount of capital engaged in this industry, not including telegraphy, is as follows: England $100,000,000, France $150,000,000, Germany $200,000,000, Austria, Italy, Spain and Switzerland $180,000,000; Russia, Sweden, Norway and Denmark $50,000,000; United States $450,000,000, Canada and other American countries $50,000,000, making a total of about $680,000,000 in Europe and $500,000,000 in America.

Educational.—The article by Mr. Wilke mentioned in the Digest last week is concluded in the "Zeit. f. Elect. u. Electrochem.," March 15.

Maxim.—"Cassier's Mag." for April contains a long, well illustrated article by Mr. Smith on "Some Features of the Inventive Career of Hiram S. Maxim;" although dealing mainly with his other inventions some reference to those in the electrical field is given.

Scientific Foundations of Electrical Engineering.—A paper by Mr. Bailey read before the Northern Soc. of Elec. Eng. is reprinted in full in "El'ty," April 3.

Manual Training.—A second article by Dr. Henderson on manual training is published in the "Pop. Sc. Mo." for April.

Digest.—The number of journals which were examined and abstracted for this department during the first three months of the present year is as follows: foreign 262, American 188, total 450, or nearly 35 journals per issue.

New Books.

THE TELEPHONE HAND-BOOK. By Herbert Laws Webb. Chicago: Electrician Publishing Company. 146 pages, 128 illustrations. Price, $1.

In the preface to this useful little book the author states that its object is to meet a demand for a practical book on telephone working and management, and that with the exception of a few descriptions the matter is based entirely on American practice.

The first several chapters give in simple language the theory of the telephonic transmission of speech and of the telephone microphone and accessories, following which are a dozen or more chapters descriptive of numerous forms of telephone receivers and transmitters. A number of chapters come next relating to batteries and their management, magneto bells, switches, line construction, circuits, installations, inspection and maintenance, etc. Other topics treated are the condenser in telephony, electromagnetic retardation, long distance and duplex telephony, simultaneous telegraphy and telephony, exchange working, party lines, the bridging bell, etc.

We have no hesitancy in saying that the work is by far the best practical treatise on the modern practice of telephony yet written, and we can recommend it with confidence to those engaged in practical telephone work, as well as to students and others desiring to obtain an intelligent knowledge of the subject. We regret to add that the mechanical execution of the book is far from being in keeping with the value of its contents.

The National Electric Light Association has published in book form the proceedings of the Washington Convention, held in February, 1894. The binding and typographical work are of the very acceptable style which characterized the previous volumes of proceedings, and the book is given, by Mr. C. F. Scott's paper on the transmission of power by polyphase currents, a permanent value which the average convention record could not be expected to attain. The illustrated lecture of Messrs. Martin and Stieringer also gives special interest to this volume of proceedings.

Public Reception of the Edison Electric Illuminating Company of Brooklyn.

On April 3 the officers and directors of the Edison Electric Illuminating Company of Brooklyn gave their annual reception, which was rendered of more than usual interest by the opportunity given to inspect the new machinery in its First District station in Pearl street.

In order to add to the interest of the occasion a large number of very interesting exhibits illustrating the progress of electrical science were shown. The guests upon entering the building were ushered into the new Otis electric elevator, which carried them to the third floor, where they entered a large tiled main hall in which was located an exhibition platform. Here were seen in operation electric motors, incandescent lamps of different candle power in various colors, and every kind of electric cooking utensil. One of the exhibits here which attracted particular attention was the Quimby hydraulic elevator pump by means of which it is possible to operate the present hydraulic apparatus by electricity far more economically than by steam pumps, and it is therefore fast finding favor among users of elevators.

The lecture room was given over to a large number of novel exhibits, including a new direct-connected elevator outfit, built by the A. B. See Manufacturing Company, in full operation. With this elevator system energy is only consumed when it is in actual operation. There are already some hundred of these elevators in use in the city of Brooklyn.

Dr. Hutchinson, of the Long Island College Hospital, kindly furnished his services for the evening to illustrate the use of medical apparatus. Among the apparatus shown were a private collection of Dr. Hutchinson and devices by the Monarch company, Messrs. J. C. Vetter & Co., and the Meyrowitz Company. Mrs. Lempke, the well-known lecturer, illustrated the use of different electric cooking utensils, of which a very large number were on exhibition. This excited great interest among the lady visitors, who saw meat roasted and cakes baked within a few feet without the usual accompaniment of distressing heat.

Among the exhibits which appealed strongly to the ladies was that of a piano operated by an electric attachment made by the Automaton Piano Company. This attachment can be fitted to any ordinary piano and renders it possible to produce the most difficult music without human aid.

In the meter room the Edison electrolytic meter was explained to the visitors.

The guests were taken along the gallery in front of the large distributing switchboard, and the various meters and switches for controlling the underground circuits and regulating the E. M. F. were explained. Much interest was manifested in the new plant, which is described in another column, particular curiosity being manifested as to the "boosters."

The space in the engine department left for future machinery was occupied by a number of exhibits, including one by the De La Vergne Refrigerating Company. With the process of this company employing electric motors it is possible to furnish cooling power and ice at much less cost than by the older methods. On the same floor was an exhibit of the Edison street arc light system, which has recently been put in such extensive use in the streets of Brooklyn. The exhibit included the automatic clock switch used for turning on and off the lights, as well as a model of the underground system of service mains to which the pole was connected. Near this exhibit was one of the water pail forges, which excited much surprise among the visitors, who saw the smith heating his iron by simply dipping it in water.

New Telephone.

Another exhibit of interest to the ladies was a sewing machine run by an electric motor and operated by Mr. Ellis who did a large amount of fancy embroidery upon thin material. The General Incandescent Arc Light Company of New York had an exhibit of low tension arc lamps, including a variety of ornamental designs for inside lighting.

The officers of the Illuminating Company are Mr. Ethan Allen Doty, president; Mr. Royal C. Peabody, secretary and treasurer, and Mr. W. S. Barstow, general superintendent.

Aluminum Diaphragm Telephone.

The new telephone herewith illustrated is being introduced by the Pittsburgh (Pa.) Telephone Company. The feature of the instrument is the compound aluminum diaphragm, which is claimed to give the most perfect results so far obtained. With this diaphragm it is said to be possible to carry on conversation eight to ten feet away from the transmitter and at four to six inches it is said to be equal to the best long distance transmitters. A new non-infringing receiver hook is another feature of the instrument. The outfit is made in the most familiar form in order not to confuse any one using it for the first time. The aluminum diaphragm is very resilient and will respond to vibrations as low as 16,000 and as high as 24,000 per second. It withstands oxidation and exposure to weather and is highly polished and tempered.

These telephones are not an experiment, but are now in use on grounded circuits from 58 to 130 miles in length. In one instance 13 instruments have been operated in series on grounded circuit 116 miles long, and successful results are claimed to have been obtained on a metallic circuit 300 miles long.

Some Improved Electric Search Lights.

Although electric search lights have long been included by the navy in the category of indispensable equipment, their use in commercial marine service has been restricted by reason of the great cost and the necessity of skilled attendance. These objections are said to be entirely removed in the Rushmore and the Huntington search lights, manufactured by the Rushmore Dynamo Works, Jersey City, which are now extensively used in all classes of land and marine service. A few of the most recent types of the Rushmore lights are shown in the accompanying illustrations.

Fig. 1.—Improved Search Light, 40,000 Candle Power.

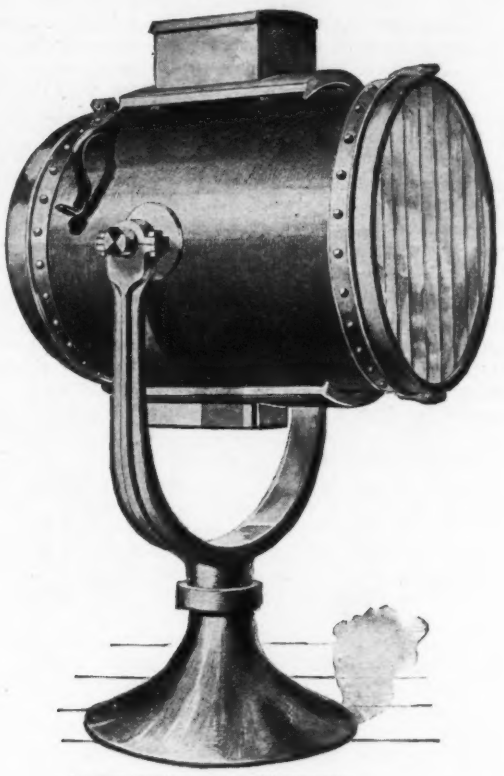


Fig. 2.—Improved Search Light, 12,000 Candle Power.

Fig. 1 shows the lens mirror projector designed for large steamships and places where a very powerful light is required; this type is built in sizes from 15,000 to 40,000 cp. Fig. 2 shows the standard plain light for smaller vessels, where a cheaper and less powerful light is required, and Fig. 3 is the standard pilot-house light, specially designed to be placed on top of the pilot-house, where it can be operated by the man at the wheel.

The Rushmore works also makes the well-known Huntington lights, which are built to operate on any direct-current circuit—constant current or constant potential. The feeding mechanism is of liberal proportions, and the feed is not affected by the position of the light when used for flashing signals on the sky at night. The construction is such that an ordinary mechanic can make repairs when required.

These lamps are now extensively used in conducting engineering work at night, and a large number have recently been sold to electric railways for use in attracting crowds to places of amusement along their lines.

Telephone Troubles.

The question of the alleged disturbance of the telephone service, says the London *Electrician*, has been discussed with the representatives of the National Telephone Company, and as a result, the following report has been submitted by Mr. Dane Sinclair, its engineer: "With reference to the disturbance on our wires, caused by the circuits of the arc lighting at Portsmouth, I have now the result of the test made on Saturday, and it proves conclusively that, if the corporation so arrange their circuits as to balance the amount of work done by each conductor, the trouble caused to our subscribers will disappear; and as this means that it would only be necessary to put an equal number of lamps, arranged alternately, on each of the two conductors forming the cable, the work, in my opinion, ought to be done at comparatively little cost."

A Compact Air or Gas Compressor.

We illustrate below an air or gas compressor built by the Philadelphia Engineering Works, Ltd., Mifflin street, Philadelphia, which is particularly compact and simple in design. It will be noticed that the air pump is set tandem with a Corliss engine, giving the combination the appearance of an ordinary tandem compound engine. There is a specially heavy box frame under both cylinders, giving continuous contact with the foundation with a view to obviating all vibration.

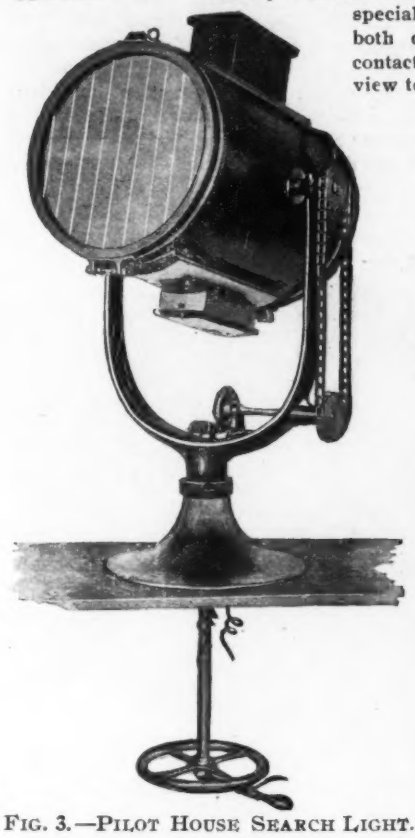


FIG. 3.—PILOT HOUSE SEARCH LIGHT.

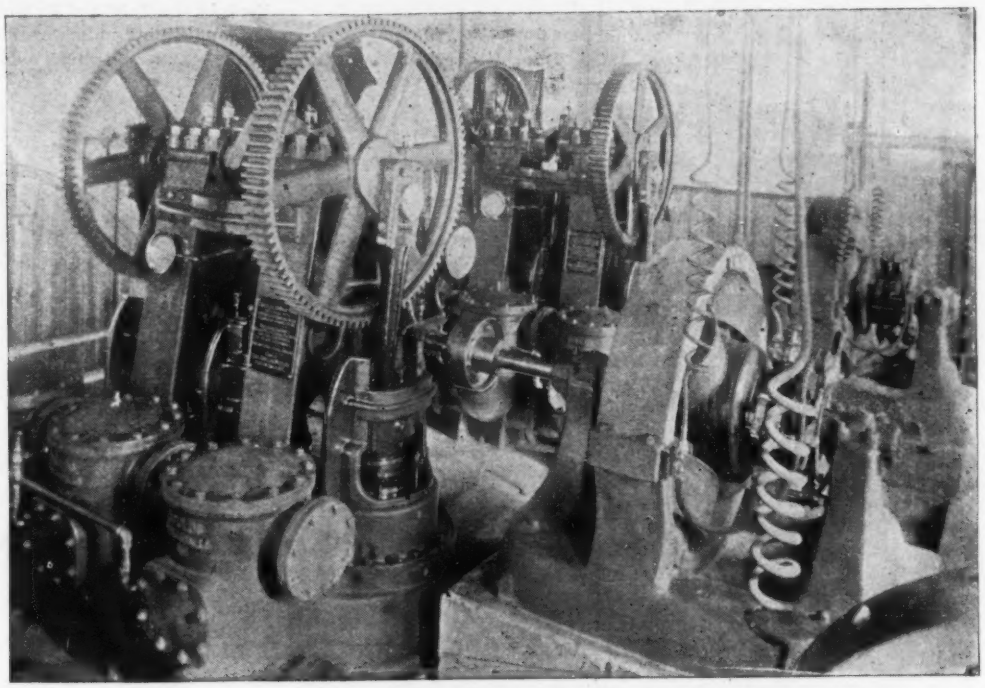
The valves are all operated by one eccentric, a connecting rod being used to transmit the motion of steam chest wrist-plate to the wrist-plate controlling the pump valves. The inlet valves of the pump are operated coincidently with the exhaust valves of the steam cylinders. The outlet valves are closed positively by the valve gear at the moment the pump piston reaches the end of its stroke, but the gear has no control over the opening of these valves, and they remain closed until the pressure within the pump attains a value equal to that of the pressure in the mains. This is accomplished by giving the small cylinders on the pump valve bonnet a greater diameter at one end than at the other and connecting the smaller end with the discharge main, and the larger end with the pump cylinder. When the pressure in the pump reaches that in the main the preponderance of force on the pump side of the valve, due to the difference in area between the two ends of the small valve cylinders, causes the valve to instantly open wide. There are no catches, hooks or springs; the valve is left closed by the valve gear, and reopened by the pressure within the pump cylinder.

The smaller sizes of these pumps are guaranteed to work well up to 100 revolutions per minute.

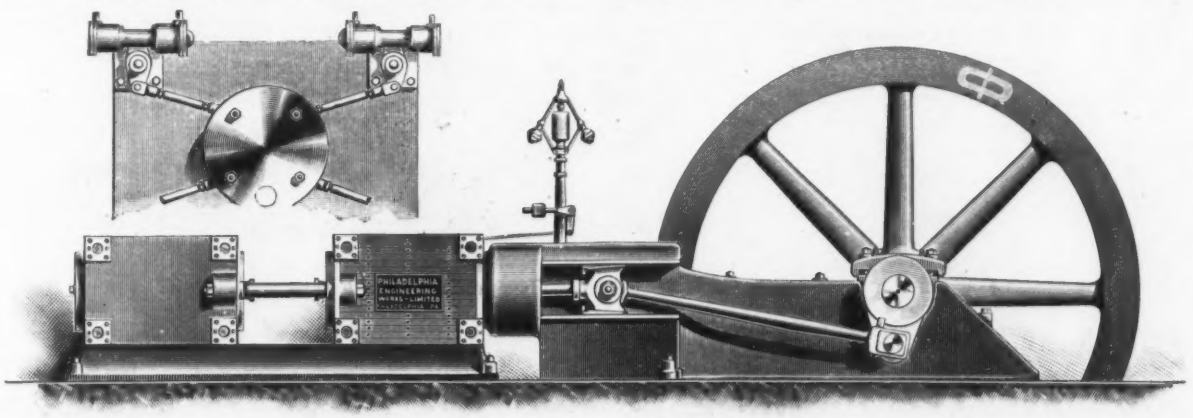
For excessively high pressures the pumps are compounded, one pump receiving the fluid and compressing it into a cooling receiver from which a smaller pump takes it and brings it up to the ultimate pressure.

Electric Pumping Station.

The accompanying engraving illustrates a complete electrical pumping plant for domestic and fire service, which has been installed at De Kalb, Ill., by The Gould Company, of Chicago. The installation consists of a 10-inch drilled well from which water is drawn by a deep-well pump driven by a 30-hp electric motor. The water from this pump is discharged into a reservoir near the pumping station, from which it is pumped into the mains by two 10″ x 12″ Goulds pumps, also operated by electric motors. The mains are so arranged that all water not consumed during the time of pumping is carried to a standpipe from which it goes to the mains when the pumps are idle, giving a constant flow. The pumps are of the triplex pattern, having three pistons 10 inches in diameter with 12-inch stroke, and are directly connected to a 70-hp multipolar slow-speed motor by means of rawhide pinions. At 43 strokes per minute the capacity of each pump is 500 gallons. For domestic service the pumps work against a pressure of 60 pounds, but are capable of working against a pressure of 125 pounds for fire service. An automatic device is used for closing the standpipe connections from the mains in case of fire. As the capacity of these pumps is far in excess of the needs of domestic duty, they are used on alternate days so that both pumps may easily be kept in good working condition. In case of fire both pumps may be employed, giving a combined capacity of 1,000 gallons working against a pressure of 125 pounds.



AN ELECTRIC PUMPING PLANT.



PHILADELPHIA AIR OR GAS COMPRESSOR.

The current to operate the motors is furnished by the De Kalb Electric Company, being transmitted from the power station to the pumping station, a distance of 3,000 feet. Five feeders are used, and three feed wires, non-interference being insured by the use of duplicate pole lines. This arrangement of wiring gives complete control of the motors, thus rendering it possible to start or stop them at a moment's notice.

In the contract between the city of De Kalb and the De Kalb Electric Company the latter assumes all care and attention of the machinery in consideration of a price of four cents per 1,000 gallons of water pumped.

This contract is advantageous to the city in many ways, but especially in that the city has to assume no responsibility of the expense or maintenance of the plant.

New Riker Motors.

The fan motor which we illustrate below has been brought out this season by the Riker Electric Motor Company, of 45 York street, Brooklyn, and possesses several improvements over last year's type. The parts of the machine, which are interchangeable, are thoroughly protected from

1895 Riker Fan Motor.

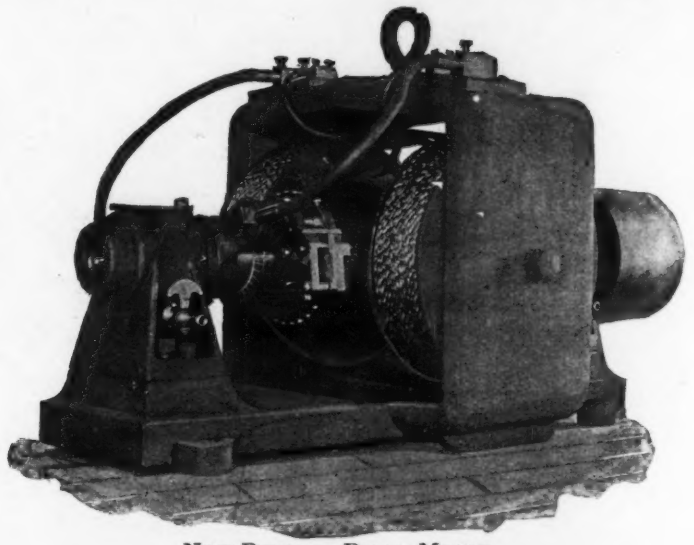
dust, though easily accessible. The body of the motor is made of cast steel and the base and bearings of cast iron. A variable resistance, enclosed in the base, enables one to run the fan at different speeds, ranging from 900 to 1,800 revolutions per minute. The fan is 12 inches in diameter and at 1,800 revolutions the motor is said to require ¼ ampere at 120 volts.

A new type of bi-polar machines made by the same company is also illustrated herewith. This form is used for machines of from ¾ to 7½ kilowatts capacity. The outer magnet frame and base are cast in a single piece of steel; the magnet cores are cylindrical within the coils, but provided with pole shoes, and are bolted to the frame.

The armature is of the toothed drum type, and all details are thoroughly worked out. The best material and workmanship are embodied throughout in the construction of the machines.

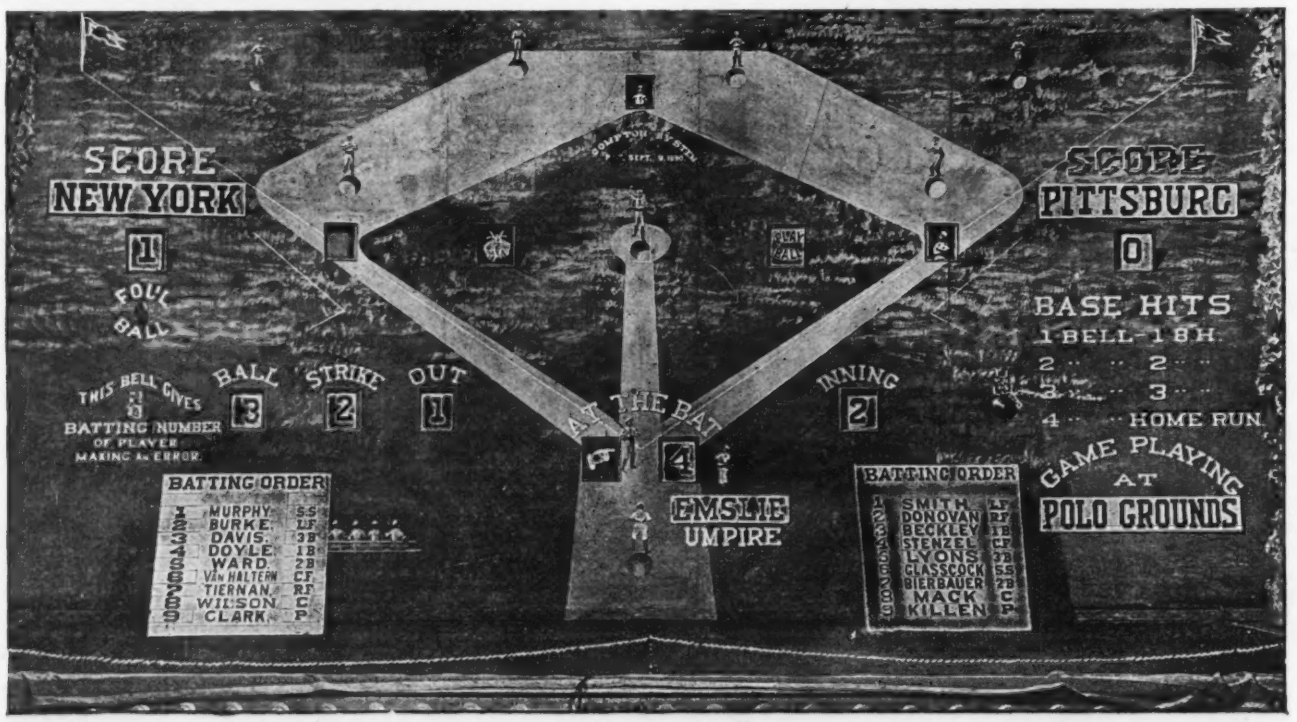
Baseball Electrically Reproduced.

The accompanying illustration gives an excellent idea of the Compton Electric Baseball Reporter, invented by Melville D. Compton, Postal Building, New York. As the cut shows, a baseball field is painted on a curtain, and apertures are left in the curtain at each playing position and under the words "Score," "Ball," "Strike," Out," and "Innings." The two teams are distinguished by colors; thus if New York is white and Pittsburgh brown, when New York is at the bat the round apertures under the fielders will be filled by a brown disc, and the other apertures are backed with white. The illustration shows New York in the field and Pittsburgh at the bat. The number at the right of the home plate indicates that player No. 4 is batting, while the numbers at the other apertures outside the diamond show that the inning is the



New Bipolar Riker Motor.

second, the man at bat has had three balls and two strikes and one man is out. The square apertures near the bases indicate a man each on first and second. Should the batter knock a foul a buzzer on the left indicates the fact; if a base hit is struck the bell on the right makes it known, and the batter is represented by a figure in the square hole near the base



Electric Baseball Bulletin.

when he reaches it. When a fly is struck a large "blue-bottle" appears at the opening between the pitcher and third base.

The contrivance is manipulated by an operator who is in communication with the grounds and receives by telegraph the necessary information throughout the progress of the game. It was shown in actual practice at the Standard Theatre last summer, where the series of games played on the Polo Grounds by the New Yorks was followed by an enthusiastic and appreciative audience.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, April 6, 1895.

THE RECENT FLURRY in electrical stocks has spent itself, and the principal stocks have continued to steadily recede from the exalted points attained week before last. General Electric has fallen off 2¼, Westinghouse 1½, Electric Storage 1, and American Bell 10, from last Saturday's closing prices.

METROPOLITAN TRACTION continues to afford some little excitement, and to draw forth numerous hypotheses as to the why and wherefore of its behavior. The stock broke to 83½ at the first of the week, and then rallied to 88¼. There has been considerable pressure brought to bear upon the management with a view to having a detailed statement of the company's affairs made public, but without avail. President Widener and Secretary Warren maintain that the company has earned every dividend that has been paid, and that its affairs were never in better shape than now. It is said that the antagonism proceeds chiefly from the firm of Chas. D. Barney & Co.

THE STANDARD TELEPHONE COMPANY, capital stock $160,000,000, the existence of which has just leaked out, claims to be in position to give American Bell serious competition. Thurlow Weed Barnes is president of the new concern, and the directory is a very strong one. Detailed information is given in other pages of this issue.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	97¼	98⅛
" " " Brooklyn	100	..	108
" " " Boston	100	..	..
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	29½	..
General Electric	100	33¼	33⅜
General Electric, pref	100	63	66
Westinghouse Consolidated, com.	50	34	34¼
" " pref	50	51	52

BONDS.

Edison Electric Ill., New York	100	105½	105½
Edison Electric Light of Europe	100	75	85
General Electric Co. deb. 5s	100	..	90¼

TELEGRAPH AND TELEPHONE.

†American Bell Telephone	100	182	..
American District Telegraph	100	30	40
American Telegraph & Cable	100	89	91
Central & South American Telegraph	100	117	120
Commercial Cables	100	137	..
Erie Telephone	100	51	51½
Gold & Stock Telegraph	100	105	..
New England Telephone	100	71	72
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	63½	..
Western Union Telegraph	100	86⅞	86⅞

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	15	15¼
Binghamton RR. com	100	100	..
Brooklyn Traction	100	9	11
" " pref.	100	..	53
Buffalo St. Ry	100	66½	69
Cleveland City Ry	100	68	70
Cleveland Electric Ry	100	59	60
Chicago City Ry	100	305	315
Columbus St. Ry	100	46	49
Consolidated Traction of N. J	..	30	33
Electric Traction, Philadelphia	50	78½	79
Long Island Traction	100	7⅞	9¼
Louisville St. Ry. com.	100	37	39
" " " pref.	100	87	88
†Metropolitan Traction, Philadelphia	100	87½	87¾
New Orleans Traction	100	15	18
" pref.	100	56	60
North Shore Traction	100	..	..
" " pref.	100	74	83
People's Traction $30 pd.	25	55¼	55½
‡Philadelphia Traction	50	79¼	80
Rochester St. Ry	..	38	..
Union Ry. (Huckleberry)	100	112	115
West End, Boston	100	63	63½
" " pref	100	87½	..
Worcester Traction	100	..	13
" " pref	100	77	80

BONDS.

Buffalo St. Ry. 1st con. 5s	100	101	..
*Binghamton Railroad Co. 5s	100	99	100
*Columbus St. Ry. 1st 5s.	100	9	..
Rochester St. Ry. 1st. 5s.	100	95	97
*Union Ry. 1st. mtge 6s.	100	105	108
*Westchester Electric 1st. mtge. 5s.	100	98	101

* With accrued interest.

† Ex-div.

‡ Ex-rights.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 BROADWAY, NEW YORK, April 8, 1895.

MRS. SCHUYLER S. WHEELER, wife of Dr. Wheeler of the Crocker-Wheeler Electric Company, died on Monday of this week after an illness of several months. Dr. Wheeler will have the sincere sympathy of the entire electrical fraternity in his grievous affliction.

MUNICIPAL OWNERSHIP.—The New York State Assembly has passed a bill requiring the submission of the question of municipal street railway ownership to ballot by the people. At the same session a resolution was passed ordering a sweeping legislative investigation of the condition and management of street railways, surface and elevated, now operated within municipalities.

ELECTRICITY AND THE NEW YORK CENTRAL RAILWAY.—President Depew proposes to forestall the Ely electric railway between Buffalo and Niagara by the adoption of electricity for motive power on the lines of his company between these places. It is proposed to run the trolley cars between the schedules of steam trains. There is also said to be a big scheme on foot among the New York Central capitalists to purchase all the water powers on the Black River between Carthage and Dexter, including those in Watertown, for the purpose of utilizing them in the generation of electricity. The electricity is to be used as a motive power on the Vanderbilt railroads in Northern New York.

THE BROOKLYN CITY AUTHORITIES have forwarded to Albany a bill requiring the immediate equipping of electric cars with fenders. It provides that "the Mayor, the Commissioners of Police and Excise, and the Commissioner of City Works shall proceed to investigate in such manner as they deem best as to the style or plan and material of safety fenders, to be used upon the cars of the surface street railway companies operating cars by electricity in the city of Brooklyn. Such style or plan or material shall be such as, in the judgment of the officers will afford the best protection against injury from the operation of such cars, and shall include both front and wheel guards." After a selection of a fender has been made, the companies are to be informed, and within three months every road in the city must equip its cars, front and rear. Any company failing in this will be liable to a penalty of $100 for each and every car not so furnished and provided. The officers of roads not promptly complying with the law shall be guilty of a misdemeanor.

PITTSBURGH NOTES.

PITTSBURGH, APRIL 6, 1895.

THE OHIO VALLEY ELECTRIC LIGHT & POWER COMPANY, of Avalon Pa., has received the contract for lighting the borough of Bellevue.

THE SECOND AVENUE TRACTION COMPANY of this city has completed its new power house at Glenwood in the Twenty-third Ward, and the additional power has given the company much needed facilities for the rapidly growing traffic on its lines.

AN ORDINANCE has been presented in Councils of this city having for its object the placing of electric light and telephone wires under ground. A similar measure was adopted some years ago compelling electric light and power companies to place their wires under ground in the lower portion of the city, but the present measure is of a more extensive scope and takes in the principal thoroughfares throughout Pittsburgh.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has now completed the removal to its new shops at East Pittsburgh, and the old place on Garrison Alley looks quite deserted. The task of removing such large shops was a gigantic undertaking but it was accomplished without the operation of manufacture being interrupted. The new shops are certainly the finest and most complete plant for the production of electrical apparatus in the country, if not in the world.

CANADIAN NOTES.

TORONTO, CAN.—It is reported that the street railway lines are to be extended in various directions in this city. John Brown, J. C. Morgan and others are interested.

WATERLOO, QUEBEC.—A local war is on between the Bell Telephone Company and the Citizens' Company.

ST. JOHN, N. B.—St. John Gas Light Company has been absorbed by the St. John Electric Street Railway Company.

SARNIA, ONT.—An act to revive the charter of the Sarnia & Lambton Southern Railway is now before the legislature.

MONTREAL.—At the annual meeting of the Auer Incandescent Light Company the report presented showed a net profit of $41,000 on the year's work.

TORONTO, ONT.—The Toronto Street Railway Company has taken over the Scarboro Electric Railway, which, it is understood, will be operated as an independent line.

OTTAWA, ONT.—J. C. Mullin, late foreman of the Electric Car Works in this city, has resigned his position and left for Valparaiso, Chili, where he goes into the electric supply business.

ST. JOHN, N. B.—Sealed proposals will be received until April 15, by Robert Wiseley, director of the Department of Public Safety, for the lighting of the streets of this city with electricity.

OTTAWA, ONT.—Thos. Ahearn has been succeeded as resident manager of the Bell Telephone Company, in this city, by D. C. Dewar, who for many years has acted as Mr. Ahearn's assistant.

HAMILTON, ONT.—The Hamilton Storage Battery Company, with a capital of $10,000, has applied to the Ontario legislature for a charter for the purpose of manufacturing storage batteries and electrical apparatus generally.

ST. LAURENT, QUE.—The Council has granted the Montreal Park & Island Railway Company a 30-year franchise for an electric railway and lighting plant to serve the whole municipality, covering a territory of 54 square miles.

TORONTO, ONT.—A bill is before the Ontario legislature to incorporate a company to build an electric railway from Toronto to Niagara Falls by the Dundas road. The power will be derived from the Niagara Power Aqueduct at Hamilton.

NIAGARA FALLS, ONT.—The Niagara Falls & Lundy's Lane Electric Street Railway Company, with a capital of $50,000, is applying for a charter to construct a street railway in the town of Niagara Falls and the township of Stamford.

MONTREAL.—At the annual meeting of the Bell Telephone Company of Canada a report was presented showing that the revenue for the past year had been $1,012,839, and expenses $729,611. The following directors were elected: C. F. Sise, G. W. Moss, W. H. Forbes, Hon. J. R. Thibaudeau, J. R. Hudson, Robert Archer, Robert Mackay, W. R. Driver and Hugh Patton.

NIAGARA FALLS.—The Niagara Falls Electric Street Railway Company, with a capital of $250,000, is applying for a charter for the purpose of constructing street railways and supplying electricity for light, heat and power purposes, in the town of Niagara Falls, and the village of Stamford, with power to acquire the Niagara Falls, Wesley Park and Clinton Tramway Company's lines. Alexander Manning, Chas. Black and A. Lash are to be the first directors.

OTTAWA, ONT.—The comptroller of customs has decided that electricity introduced into Canada for power purposes must pay a duty of 20 per cent. A commercial value will be placed upon each horse power, based upon the price paid, and on this the duty will be assessed.

OTTAWA, ONT.—The question of the right of the Dominion Government to impose a duty on electricity will be raised in Parliament next month. The clause under which the 20 per cent. duty has been imposed reads thus: "All goods not enumerated in this act as subject to any other rate of duty, nor declared free of duty by this act, and not being goods the importation of which is by this act or any other act prohibited, shall be subject to a duty of 20 per cent." The point involved is a nice one, and the discussion promises to be exceedingly interesting.

English Notes.

(From Our Own Correspondent.)

London, March 27, 1895.

THE TELEPHONE COMMITTEE.—The select committee of the House of Commons appointed to consider the condition of the telephone service of the United Kingdom held its first sitting yesterday, and will commence work seriously on Friday.

MUNICIPAL PURCHASE.—The Liverpool Town Council has for some time past had its eye on the Liverpool Electric Supply Company, which has for several years been building up a prosperous business in that city. Negotiations are now in active progress for the municipal purchase of the company's business. I hear that the company has asked for half a million sterling. As it has not spent more than half this sum, has never earned a larger dividend than 5½ per cent., and is liable to be purchased in a summary manner by the Town Council in about two years' time, it must be admitted that the sum demanded is a handsome one.

THE TELEPHONE SERVICE OF THE UNITED KINGDOM.—On Friday last the select committee of the House of Commons sat to hear evidence on the condition of the telephone service of the United Kingdom. The first witness was Mr. J. C. Lamb, assistant secretary of the post office in charge of the telegraphs department, who gave an interesting history of the introduction of telephony into this country, and of the wild oscillations of policy adopted toward Graham Bell's invention by successive postmaster generals. It is small wonder that we have arrived at the present *impasse* in view of the obvious inability of the post office officials to see further ahead than the tips of their noses, and to adopt a broad and definite policy even for this limited field of vision.

LAMP REVENUE.—As an instance of the revenue which our electric supply companies in London are now deriving from each 8-cp lamps installed, the figures recently quoted at the meetings of the City of London Electric Lighting Company and Notting Hill Electric Lighting Company are of interest, illustrating as they do the widely different conditions under which the various London companies work. The City of London Electric Lighting Company during the year 1894 derived a revenue of about 12s. 6d. per lamp; the Notting Hill Electric Lighting Company is struggling to make both ends meet on a revenue of about 6s. per annum. The Metropolitan Electric Supply Company, the biggest of our electric supply companies, so far as lamp connections are concerned, derived, if I remember rightly, in 1893, a revenue of about 8s. per lamp installed. Judging by the dividends paid by the various companies a revenue of 10s. per lamp per annum is an irreducible minimum below which it is not likely anything in the shape of a substantial dividend will be paid.

TRANSFORMER CHAMBERS.—Your readers may possibly remember that just before Christmas there was a battle royal between the London County Council and an electric lighting company, now about to set to work, called the County of London & Brush Provincial Electric Lighting Company, the bone of contention being the right of that company to excavate pits under the pavement, and to place therein the apparatus necessary for transforming their 2,000-volt current into one of 200 volts for distribution to their proposed three-wire alternate current network. No agreement could be reached, and the Board of Trade was appealed to. The government department, after a lengthy hearing, decided in favor of the company. The last word, however, seems likely to be with the London County Council. The company is now seeking powers for districts in London other than those which it already covers, and a *sine qua non* of Parliamentary sanction is that the powers asked for should have the assent of the local authorities concerned—one of whom, in this case, is the London County Council. They have, indeed, agreed to the demand of the County of London Company, but with the proviso that it should not make excavations under the footways of greater dimensions that 3 ft. span and 2 ft. 6 in. depth, thus practically prohibiting the making of transformer sub-stations under the pavements.

SUPERHEATERS.—The desire to economize heat in electric supply and other steam using works is fast developing into such a mania that it seems likely that every little unit of heat which manages to elude being put to any useful purpose will form the basis of a more or less gigantic financial manœuvre for its prompt recovery. From the coal bunker to the exhaust pipe or condenser there is nothing but one chain of ingenious economizing devices, the number of which is daily increasing. The latest financial scheme is on rather a large scale considering the scope of its action. It proposes to place a somewhat well-known superheater more firmly on the market, with a capital of no less than £416,000, of which all but £94,000 will be paid to the vendors. Whether a few degrees of heat justify so large an amount of capital it is difficult to say, for although the superheater concerned, viz., that of McPhail & Simpsons', is one which has been used in a great many works for some time, yet it is difficult to believe that there can be justification for so much capital even in the case of an ideal superheater. On the other hand, I do not in any way wish to deprecate the use of superheaters, for there can be no doubt that a considerable economy can often be introduced in electric supply stations by their use. There is more than one good superheater on the market beside that of Messrs. McPhail & Simpsons', and it is probable that the competition with these would alone be enough to make it rash to raise so much capital for the development of a single type.

STREET BOX EXPLOSIONS.—Maj. Cardew, an inspector of the Board of Trade, has just issued his report on the explosion which took place on Southwark Bridge on Feb 1, in several street boxes connected with the system of the City of London Electric Lighting Company. The inspector "can confidently assert" that electricity had nothing whatever to do with exploding the gas which had found its way into the electric light conduits. The cause of the explosion was in all probability a lighted match dropped down a gulley in which there was an explosive mixture due to a fractured gas pipe. The inspector, however, thinks that the Southwark Bridge explosion gives grave cause for anxiety, owing to the proof it afforded of the great distance a series of explosions may travel, and also on account of the proof it afforded of the inadequacy of mere ventilation unless the conduits and street boxes are more or less impervious to gas. The report concludes with some severe remarks on the slowness with which the City of London Electric Lighting Company has adopted previous recommendations of the Board of Trade, but at the same time recommending practically a new policy. Previous to the Southwark Bridge explosion, the Board of Trade laid great stress upon thorough ventilation. Great stress is *now* laid upon filling up the street boxes with incombustible material, and on the thorough plugging of the ducts at each street box, ventilation being no longer considered of primary importance; it is indeed suggested that it may be dispensed with provided the latest panacea of the Board of Trade be adopted. It is somewhat fortunate under the circumstances that the City of London Electric Lighting Company has been slow in adopting the Board of Trade's earlier recommendations. Had it spent several thousands of pounds in arranging for an elaborate system of ventilation it would now have the agreeable consolation of knowing that this was all wrong and would have had to spend more money on an entirely new cure.

General News.

New Incorporations.

THE STAUNTON MUTUAL TELEPHONE COMPANY, Staunton, Va., capital stock $25,000, has been incorporated by R. S. Turk, W. L. Oliver and others.

THE MAINE LIGHTING COMPANY has been incorporated at Portland, Me., with a capital stock of $10,000. Arthur C. Libbey is president and L. W. Tibbetts is treasurer.

THE HINTON TELEPHONE COMPANY, Hinton, Va., has been incorporated by J. T. McCreery, Harvey Ewart, P. K. Litsinger and others to establish a telephone system.

THE MUTUAL AUTOMATIC TELEPHONE COMPANY, Brooklyn, N. Y., has been incorporated by David A. Boody, Silas B. Dutcher and others. The capital stock is $6,000,000.

THE WOODLEY LAND COMPANY, Washington, D. C., has been incorporated with a capital stock of $87,000,000, by Jno. J. Hemphill, Alex. S. Porter, and others, to establish an electric light plant.

THE STEUBEN COUNTY ELECTRIC TELEPHONE COMPANY, Angola, Ind., capital stock $5,000, has been incorporated by Lorenzo Taylor, Sol. A. Wood, J. E. Naught and N. W. Gilbert, of Angola.

THE RAWSON LIGHT & POWER COMPANY, Leicester, Mass., capital stock $25,000, has been formed to supply light, heat and power. Those interested are E. L. Watson, W. C. Watson and W. F. Wittemore.

THE INTERSTATE TELEPHONE COMPANY, Durham, N. C., capital stock $100,000, has been incorporated to manufacture telephones, etc. Edgar L. Miller, J. S. Carr and Dr. Fahrney, of Frederick, Md., are interested.

THE MULTIPHASE MOTOR COMPANY, New York, capital stock $200,000

has been incorporated by Alfred S. Brown, George. W. Gardanier and Watson D. Schrain, to make and sell electric motors and other electrical machinery.

THE HARRISON TELEPHONE CONSTRUCTION COMPANY, Louisville, Ky., capital stock $100,000, has been incorporated by G. A. Dole, Minneapolis, Minn.; J. C. Strother F. H. Barney, H. K. Cole and D. M. Goodwin, Louisville.

THE WESTERN MARYLAND TELEPHONE COMPANY, Westminster, Md., has been incorporated with P. J. Bennett, president; Chas. E. Fink, vice president; J. M. Reifsnider, secretary and treasurer, and H.B Hazlett, general manager.

THE GREENVILLE ELECTRIC LIGHT, HEAT & POWER COMPANY, Greenville, Mo., has been incorporated with a capital stock of $25,000. E. Bruckman and Samuel D. Bruckman are among the incorporators, and can be addressed.

THE AUSTIN ELECTRICAL COMPANY, Austin, Tex., capital stock $5,000, has been incorporated to deal in electric fixtures and to do all kinds of electrical work. Among those interested are E. B. Fisher, Q. C. Horton and J. E. McGillevary.

THE LOCK HAVEN TRACTION COMPANY, Lock Haven, Pa., capital stock $10,000, has been formed to operate passenger railways by cable, electrical or other means. Chas. A. Bragg, H. I. Mitchell and George Breed, Philadelphia, Pa., are interested.

THE BRISTOL GAS & ELECTRIC COMPANY, Bristol Va., capital stock $100,000, has been formed to operate a gas and electric light plant. The organizers are J. H. Wood and H. C. Wood, of Bristol; R. W. Crenshaw and Wm. Hurt, of Lynchburg, Va.

THE PARKERSBURG TRACTION COMPANY, Parkersburg, W. Va., maximum capital stock $1,000,000, has been incorporated to build and operate a street railway in Parkersburg. D. B. Judd, Wm. R. Hurd and Wm. C. Spring, of Bristol, Conn., are interested.

THE SARANAC LAKE (N. Y.) ELECTRIC LIGHT COMPANY, has been incorporated with a capital stock of $30.000. Orlando Blood, Wallace Murray and Orville S. Morse, of Saranac Lake, are among the incorporators, and can be addressed for details.

THE LOCK HAVEN TRACTION COMPANY, of Lock Haven, Pa., has been incorporated with a capital stock of $10,000. Charles A. Bragg, M. J. Mitchell and George Breed, of Philadelphia, are among the incorporators, and can be addressed for further information.

THE RAWSON LIGHT & POWER COMPANY, Leicester, Mass., capital stock $25,000, has been formed to furnish light, heat and power. The promoters are Edwin L. Watson, Walter C. Watson, Wm. F. Whittemore, J. S. Whittemore and Lory S. Watson.

THE COTY & ALBERTSON COMPANY, Atlantic City, N. J., capital stock $10,000, has been formed to do a plumbing, gas-fitting, hardware, electrical and other business. The promoters are Richard B. Albertson, Jos. Young and Clifton C. Shinn, Atlantic City, N. J.

THE MASCOT ELECTRIC LIGHT, HEAT & POWER COMPANY has been organized at Ouray, Col., with a capital stock of $100,000, to produce electricity for light, heat and power. B. B. Clauson, Chas. A. Armstrong, and T. W. Emerson, all of Ouray, are interested.

THE NEWTOWN, LANGHORNE & BRISTOL TROLLEY STREET RAILWAY COMPANY, Newtown, Pa., capital stock $60,000, has been formed to build an electric street railway. Geo. C. Worstail, Newtown; Henry Lovett, and Wm. B. Parry, Langhorne, Pa., are all interested.

THE SNYDER ELECTRICAL COMPANY, Cleveland, O., capital stock $5,000, has been formed to manufacture and deal in chemicals, electrical and plating machinery, supplies, etc. The promoters are Edward Snyder, Chas. E. Watson, M. M. Zellers, Geo. A. Burke and A. V. Cannon.

THE PROVIDENCE ELECTRIC THERMOSTAT COMPANY, Kittery, Me., capital stock $100,000, has been incorporated to manufacture and deal in heat and damper regulators. Lorin M Cook, Frank M. Burrough, Providence, R. I., and Buron S. Cowles, Meriden, Conn., are interested.

THE PORTLAND & YARMOUTH ELECTRIC RAILWAY COMPANY, Portland, Me., has been incorporated, with a capital stock of $200,000, for the purpose of building an electric railway between the points named. Edward S. Perry, of New Haven, is president of the company, and can furnish details.

THE ELECTROLYTIC INSULATING & CONDUIT COMPANY, Springfield, Ill., capital stock $5,000,000, has been formed to manufacture, use and sell electric conduits, cables and all electrical apparatus. The promoters are H. Clay Wilson, Benj. Knudson and Jas. E. Henderson.

THE UNIVERSAL TELEPHONE COMPANY, Indianapolis, Ind., capital stock $25,000, has been formed to manufacture and sell telephones, telephone devices, electrical supplies, etc. The promoters are E. B. Martindale, Chas. Martindale, and Robert Martindale, Indianapolis, Ind.

THE TALLAHASSEE SHOALS ELECTRIC COMPANY, Athens, Ga., has been incorporated, with a capital stock of $50,000, for the purpose of developing the water power of the Tallahassee Shoals for electrical purposes. The secretary of the company can furnish detailed information.

THE MARKET STREET, RICHMOND & FRANKFORD ELECTRIC RAILWAY COMPANY, of Philadelphia, has been incorporated for the purpose of building an electric elevated railway between the points named. The secretary of the company can be addressed for detailed information.

THE PLYMOUTH COUNTY RAILWAY COMPANY, East Weymouth, Mass., has been incorporated, with a capital stock of $250,000, for the purpose of building an electric railway between this place and Brant Rock, a distance of 25 miles. John F. Simmons is president and Charles H. Killam treasurer.

THE KELSEY ELECTRIC RAILWAY SPECIALTY COMPANY, New Haven, Conn., capital stock $20,000, has been formed to manufacture electrical supplies and specialties and car supplies, hardware and machinery. Frank N. Kelsey, Chas. L. Wright and Wm. W. Miner, New Haven, Conn., are interested.

THE STREET RAILWAY COMPANY OF SAVANNA, Savanna, Ill., capital stock $25,000, has been formed to construct, maintain and operate a street railway by animal, electric or pneumatic power. W. W. Cargill, J. B. Canterbury, Edwin B. Magill, A. D. Appleby and B. Pulford are the interested parties.

THE KANSAS TELEPHONE & ELECTRICAL COMPANY, Parsons, Kan., capital stock $40.000, has been formed to maintain and operate a system of telephones and electrical alarms and calls. The promoters are A. B. Kerlin, Freeport, Ill.; D. S. Stewart, Shelbina, Mo., and C. W. Ryan, Parsons, Kan.

THE BERWYN & DEVEN PASSENGER RAILWAY COMPANY, Philadelphia, Pa., has been organized to build a street railway in Chester county. The promoters are Geo. Boney, 1,925 North Seventh street; John. A. Barry, 225 South 33d street; Russell Hawkins, 3,238 Chestnut street, Philadelphia, Pa. Capital stock, $10,000.

THE MIDDLEBURG & OAK HILL TELEPHONE COMPANY, Middleburg, N. Y., capital stock $50,000, has been incorporated to contruct a line from Middleburg to Livingstonville, Lawyefsville, Preston Hollow, Oak Hill and Durham. The organizers are Elias W. Dutton, Azano B. Brayman, W. J. Chase, William Earle and others.

THE DOVER ELECTRIC LIGHT & POWER COMPANY, Dover Plains, N. Y., capital stock $10,000, has been formed to carry on the business of lighting cities, towns, villages by electricity, and to supply same for heat and power. The promoters are Adolph Reimer, Catherine Reimer, of Dover Plains, and J. C. Muick, of Brooklyn, N. Y.

THE PROSPECT STREET RAILWAY COMPANY, Chester, Pa., capital stock $50,000, has been formed to build a street railway operated by electricity or other power than locomotive. Geo. Rodgmen, 315 West Second street; Wm. D. Pullon, Jr., 614 West Sixth street, and Edw. L. Nugent, 540 East Eighth street, Chester, Pa., are interested.

THE ENBALM CONDUIT TROLLEY COMPANY, New York, maximum capital stock $5,000,000, has been incorporated to manufacture, acquire and sell all sorts of machinery and inventions, and to construct and equip steam and electric railways, etc. Glenn S. Smith, of Brooklyn; Oscar A. Enbalm and Clarence E. Sherin, of New York, N. Y., are interested.

THE TELEGRAPHIC PAGE PRINTING COMPANY, New York, maximum capital stock, $500,000, has been incorporated to manufacture, operate and sell electric printing telegraph machines and all other electrical and mechanical devices, etc. The incorporators are Edw. T. Hickey and Chas. H. H. Cottrell, of New York, and Chas. F. Sesinger, of Philadelphia, Pa.

THE CHASE ELECTRIC CYCLORAMA COMPANY, Chicago, Ill., has been incorporated with a capital stock of $100,000 to manufacture, buy and sell and operate electrical, photographic and optical machines, instruments and apparatus, stereopticon slides, lime-light and all other lighting apparatus. Chas. A. Chase, D. Wiley McCaughey, and Geo. E. West are the promoters.

THE TOPEKA WATER & ELECTRIC POWER COMPANY, Topeka, Kan., capital stock $1,000,000, has been incorporated to develop and improve water power from Kansas River and other places; construct dams, electric works, water works, etc, etc. The incorporators are F. A. Session, Jonia; L. H. Withey, Anton C. Hoclenpyl and T. F. McGarry, Grand Rapids, Mich.

THE MORAGA VALLEY RAILWAY COMPANY, San Francisco, Cal., capital stock $500,000, has been formed to build and operate railways in Contra Costa County by steam, electricity or other motive power, and to lease, purchase and sell railways. Angus A. Grant, Albuquerque, N. M.: Archibald J. McDonald, San Francisco, and John T. Williams, Oakland, Cal., are the incorporators.

THE CHICAGO WESTERN COAL & MINING COMPANY, Chicago, Ill. capital stock $500,000, has been formed to manage, operate and conduct the business of mining and selling coal and other minerals, to construct and operate plants, power houses, and all necessary appliances for producing electricity for light, heat and power. Edw. W. Russell, Frank H. Russell and Lawrence Browne are interested.

THE SAN JOAQUIN ELECTRIC COMPANY, Fresno, Cal., capital stock $800,000, has been formed to buy, sell and deal in electrical inventions, patents, etc., also to buy, sell, lease, maintain and operate electrical plants of all kinds, to generate and sell electricity and to deal in real and personal property. John J. Seymour, John S. Eastwood, Henry Sherwood, O. W. Woodward, and L. L. Cory, of Fresno, are interested.

TELEGRAPH AND TELEPHONE.

FREDERICK, MD.—The Interstate Telephone Company is about to construct its system.

GREENVILLE, TENN.—The East Tennessee Telephone Company, of Knoxville, will construct a telephone system here.

CHATTANOOGA, TENN.—The East Tennessee Telephone Company will extend its lines to Jasper, South Pittsburgh and Bridgeport.

FREDERICKSBURG, VA.—The Woodbridge & Occoquan Telephone Company has obtained a franchise and will establish a telephone system.

FLORENCE, ALA.—Steps are being taken to establish a telephone system. Robt. Andrews, W. M. Price, Jno. W. Hall and others are interested.

WARREN, TEX.—The Warren Land & Lumber Company contemplates constructing a telephone system including a 15-mile line to its logging camp.

NASHVILLE, TENN.—A bill has passed the House which limits telephone rentals in Tennessee to a maximum of $3 per month on each instrument.

ELIZABETH, N. J.—The City Council will purchase a quantity of electrical apparatus for the use of the fire department. The clerk can be addressed.

ROME GA.—A telephone system is being organized by J. W. Dodds, of Cedartown, and G. G. Leake, of Marietta; over 100 subscribers have been secured.

COLUMBUS, GA.—The Bell Telephone Company will construct a long distance telephone line from Griffin to Columbus by way of Warm Springs, Greenville, Hamilton and Chipley.

THE WINNSBORO & RIDGEWAY TELEPHONE COMPANY, Winnsboro, S. C., has been granted a charter to construct a telephone line, twelve miles in

length. W. D. Douglass, Jas. Q. Davis, E. C. Heins and M. W. Doty are interested.

PHILADELPHIA, PA.—The electrical department will shortly begin laying conduits on Second street from Market to Diamond; on Callowhill street from 23d to 25th street; on 25th street from Callowhill to Brown; on Brown street from 25th to 26th; on 26th street from Grand avenue to Ridge avenue, and on Ridge avenue from Columbia avenue to Diamond, so as to enable the different telegraph and telephone companies to place their wires underground and utilize the city conduits instead of erecting poles and stringing overhead wires.

Miscellaneous Notes.

THE TELEGRAPHERS' MUTUAL BENEFIT ASSOCIATION has published a financial statement which shows the organization to be in a most satisfactory condition, the reserve fund being reported at $115,000. The association is heartily endorsed by the officers of both the Western Union and Postal Telegraph companies.

THE ELECTRICAL ENGINEERING SOCIETY, School of Electrical Engineering, Lehigh University, South Bethlehem, Pa., at its last meeting listened to two well prepared papers by Messrs. Klinck and Blehl. The subject of Mr. Klinck's paper was "The Jablochkoff Candle." Mr. Blehl's paper considered "Vector Analysis as Applied to Alternating Current Problems." Mr. E. C. Brown supplemented this paper by explaining a few problems to which the principles enunciated in Mr. Blehl's paper apply.

YALE TO THE FRONT.—A press dispatch from New Haven, Conn., reports that J. J. Hogan, employed in the mechanical department of Yale Scientific School, has invented an apparatus by means of which the use of the motor dynamo, invented by Edison, is obviated. The apparatus, according to the dist patch, reduces the voltage of a current without lessening the amperes. At a test made on March 25 we are informed that the machine reduced an electric light current of 100 volts and four amperes to seven volts, without affecting the amperes.

LANDING OF CABLES.—The New York State Supreme Court of the first department has recently decided the case of Hector de Castro vs. the Compagnie Française du Telegraphe de Paris à New York in favor of the latter, which was represented by Edward W. West as counsel. The plaintiff claimed a large fee for having obtained an opinion from the United States Secretary of State disclaiming authority in the matter of a State granting permission to land a cable, but the court decided that such a disclaimer was not a performance of the contract to procure a declaration of the Federal Government, assuring to the French Company "the enjoyment, without restriction and unattackable, of the landing rights which it holds from the separate government of the State of Virginia."

AN ELECTROTHERAPEUTIC CLINIC.—On Saturday of last week the New York Electrotherapeutic Clinic, Laboratory and Dispensary was opened at 327 East 25th street and will be conducted under the direction of Dr. Margaret Cleaves. This clinic is thoroughly equipped with all the modern electrical apparatus used in medicine, such as influence machines, alternators, induction coils, constant current apparatus (with primary batteries or cells, and with adapter for street current), storage batteries for cautery, illumination and trans-illumination, constant current and electric light baths, as well as with appliances necessary to determine with exactitude the action of electrical energy upon the human economy. Its object is to assist in the development of scientific electrotherapeutics, and instruction will be given in this branch and in electrophysics and physiology.

THE EXECUTIVE COMMITTEE OF THE NATIONAL ASSOCIATION OF MANUFACTURERS held its first meeting at the Manufacturers' Club, Philadelphia, last month, at which the following vice-presidents were elected: For Delaware, Mr. H. G Morse, president of Edge Moor Bridge Works; for District of Columbia, Mr. John T. Campbell, of Washington; for Kansas, Mr. J. L. Abernathy, of Leavenworth; for Louisiana, Hon. James H. Shakespeare, of New Orleans; for Massachusetts, Mr. Elwyn W. Lovejoy, of Lowell; for Minnesota, Mr. S. B. Foote, of St. Paul; for Montana, Mr. J. T. Carroll, of Butte City; for Washington, Mr. Thos. E. Evanson, of Seattle. The association is to be composed of other organizations representing the various industries, but its purpose is not in any way to interfere with or absorb existing societies and associations, but to consolidate them into one powerful representative body.

REDUCTIONS IN TELEPHONE CHARGES.—The Wisconsin Telephone Company, commencing on April 1, reduced its rates 25 per cent., the charges for business houses now varying from $36 to $18 per year, and for residences from $30 to $15, the highest rate being for private lines, and the lower rates for party lines. The Michigan Bell Telephone Company, on the same date, reduced its rates to $36 and $24. The company supplying the territory about Steubenville, O., has announced a reduction from $50 to $36 and $30. At Washington Pa., the rates have been reduced from $60 to $36 and $30, and the Central Union Company, of Illinois, has changed from $36 to $30 for dwellings, and from $48 to $42 for business places. The New York & New Jersey Telephone Company, whose territory includes Brooklyn, Jersey City, Newark, etc., have adopted a new schedule which lowers rates considerably, if party lines are used.

Trade and Industrial Notes.

FRANK H. STEWART, 20 North Seventh street, Philadelphia, has taken Mr. P. Logan Bockius into partnership, and the business will hereafter be conducted under the name of Frank H. Stewart & Co.

THE PACKARD ELECTRIC COMPANY, LTD., of Montreal, Can., has been incorporated and succeeds to the business of the Dominion Electric Company, Ltd., and the Packard Lamp Company, Ltd., assuming all the obligations of the two old companies.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., has just closed a contract with the Berlin Iron Bridge Company, of East Berlin, Conn., for equipping its new forge shop with electric power. A 40-kw generator and 50-hp motor will be used.

CHAS. E. CHAPIN, 136 Liberty street, New York, is selling the Perfection woven wire dynamo brush and reports a large number of orders recently received. It is claimed that the Perfection brush will not cut the commutator, and has an unusually long life.

MR. E. PECKHAM, president of the Peckham Motor Truck & Wheel Company, of New York, has returned from a two months' trip to California, whither he had gone for a little rest and recuperation. Mr. Peckham says he feels first-class, and certainly his appearance corroborates this statement.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, 50 Broadway, New York, reports business good and steadily improving as to both the Manhattan arc lamp and gauze dynamo brushes. The difficulty formerly experienced with the inner globe of the Manhattan lamp is said to have been entirely overcome.

THE HOGAN BOILER COMPANY, Middletown, N. Y., is distributing a set of sheets illustrating its water-tube boiler, both "manifold" and cylindrical types, in various stages of construction. Plans, front and back elevations and cross-sectional views are also presented. The engravings are printed on heavy plate paper.

JAMES. BOYD & BRO., 14 North Fourth street, Philadelphia, have issued a very handy and substantial catalogue of electric railway supplies, which is comprehensive in scope and logically arranged as to contents. The size of the book, 4½x8 inches, is a most convenient one for handling as well as for filing away in a cabinet or desk.

THE BERLIN IRON BRIDGE COMPANY, of East Berlin, Conn., has issued a handsome calendar for the fiscal year ending March 31, 1896. There are eleven distinct engravings lithographed in colors, showing various styles and types of work turned out by the company, including suspension, truss and cantilever bridges, iron doors, roofs, etc.

THE ROYAL ELECTRIC COMPANY, of Peoria, Ill., has completed arrangements with H. B. Coho & Co., 203 Broadway, New York, to handle its alternating current apparatus in the East. Messrs. Coho & Co. have secured the services of Mr. George C. Hoffman, formerly of the Westinghouse Company, who will have charge of their alternating current department.

THE PARTRICK & CARTER COMPANY, 125 South Second street, Philadelphia, has just issued a new catalogue of house goods and general supplies, which is complete in every detail. Among other new things noted are a very ornamental pear-shaped push, a high and low water alarm, and an automatic electric programme clock. The book is gotten up in the same excellent style which has characterized the P. & C. catalogues for several years.

THE FRANKLIN ELECTRIC COMPANY, of Kansas City, Mo., has recently completed the installation of the electric light plant at Hamilton, Mo., and a lighting plant for the State Industrial School at Lancaster, Ohio. The latter contract included erection of building and steam plant. The Franklin Company has also secured the contract for an electric light plant at Plattsburg, Mo.

H. B. COHO & CO., 203 Broadway, New York, announce that pending an adjustment of inside affairs the Mather Electric Company will be managed by Mr. Jarvis, of the Berlin Iron Bridge Company, as temporary receiver, and that with this exception there will be no change in the affairs of the Mather Electric Company, that any bids or prices quoted will stand, and that H. B. Coho & Co. are prepared to guarantee deliveries on this excellent apparatus.

F. E. BAILEY & COMPANY, Philadelphia, who for a number of years have handled the Ideal engine for the Harrisburg Foundry & Machine Works in this vicinity, have moved from 701 to 913 Betz Building, and are now representing the Armington & Sims Engine Company, of Providence. Their territory extends over quite a number of states and judging from the former success they have had, their prospects are very good for a large portion of first-class engine and boiler business.

THE ELECTRIC POWER STORAGE COMPANY, of 166 Elm street, New York, has appointed Wm. Hood as its Western representative, with headquarters at Chicago. Immediately upon the acquisition of Mr. Hood the company secured, through his management, a contract from H. H. Porter, president of the Chicago & Eastern Illinois Railway Company, for 120 350-ampere-hour accumulators for a lighting plant at Mr. Porter's summer residence at Lake Geneva, Wis. Mr. Hood is a man of unqualified ability, and there is no reason why his appointment should not be mutually satisfactory in every respect.

J. HOLT GATES, Monadnock Building, Chicago, reports the following sales of electrical apparatus for March: One 50-kw multipolar machine to Swartschild & Schulzberger Packing Company, Kansas City, Mo.; 250-hp in motors to the Bucyrus Steam Shovel & Dredge Company, South Milwaukee, Wis; one 110-kw., one 85-kw and one 60-kw multipolar machines for Pennsylvania; one 65-kw generator, direct-connected with an Ideal engine, to J. H. Garaghty, Columbus, O.; one 250-light machine to St. Paul, Minn.; one 100-light machine to Two Rivers, Wis.; two 15-kw machines to Arlington, Minn., and two 20-hp motors to the B. F. Sturtevant Company, Chicago.

THE NEW YORK & OHIO COMPANY, Warren, O., reports a large demand for its well-known Packard lamps, and in order to accommodate its rapidly growing Eastern business has recently opened a New York office at No. 1 Broadway, which will be in charge of the president of the company, Mr. J. W. Peale. The company has recently published a diagram showing graphically the increase of efficiency and candle power of its new lamp, which is claimed to give, after some hundred hours' burning, a greater amount of light with a smaller consumption of energy per candle power than when new. This is a pretty strong claim, but the company declares its readiness to back it up.

M. T. DAVIDSON, 77 Liberty street, New York, is building a pair of air pumps for the Johnson Company, Johnstown, Pa., which are believed to be the largest ever constructed in this country. The pumps are arranged to be operated singly or as compound duplex pumps. The high pressure steam cylinder is 16 x 24 inches, low pressure 30 x 24, and the air cylinder 36 x 24 inches. There are two sets of these pumps, each provided with a jet condenser 6 ft. in diameter by 12 ft. 9 in. high. They are to be used in the Johnson Company's mills at Lorain, O. The Davidson works have just completed a pair of com-

pound double plunger pumps for the same company, and reports business as being very good.

THE HEINE SAFETY BOILER COMPANY, St. Louis, Mo., feels encouraged in the character of business that is coming in, though the volume is not yet satisfactory. The last week in March the company closed contracts for both the street railway boiler plants of New Orleans, aggregating over 1,100 hp, which competitors have been working on for many months. Among other sales are the following: R. H. White & Co., Boston's big dry goods house, three boilers, 610 hp; The Equitable Building, Denver, Col, three boilers, 750 hp, to replace another type; New Planters Hotel, St. Louis, one boiler, 200 hp, and De Lamar's Gold Mining Company, De Lamar, Nevada, one boiler of 120 hp. The widespread nature of this business is certainly a favorable indication.

THE MATHER ELECTRIC COMPANY, Manchester, Conn., owing to the inability to collect accounts due, on April 6 was placed in the hands of a receiver. Chas. M. Jarvis of the Berlin Iron Bridge Company was appointed by the Superior Court of Hartford, Connecticut, as receiver in charge of all property, and as soon as possible will issue a statement of the assets and liabilities. By order of the court the company is allowed to proceed with the manufacture of electrical apparatus in order to close out the large amount of machinery and material now on hand, nearly all of which is already sold. It is hoped that the receivership is but temporary, but an inventory is now being taken and as soon as completed all creditors will be fully informed as to the exact condition of affairs. All material in the shape of supplies received by the company after 10.10 a. m. on Saturday, April 6, 1895, will be paid for by the receiver. Material and supplies received before that time will be credited on the accounts of the Mather Electric Company.

Business Notice.

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED APRIL 2, 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

536,608. ELECTRICAL TRANSFORMER; M. Dickerson, Fort Wayne, Ind. App. filed Nov. 26, 1894. The combination of primary and secondary coils with a continuous surrounding envelope of laminated iron, each lamina having a cross plate entering within the coils, so arranged that by the abutting edges of the plates being out of coincidence with those of each reversed adjacent or alternate lamina they will break joints.

536,655. TERMINAL ATTACHMENT FOR FLEXIBLE CONDUCTORS; W. L. Richards, Malden, Mass. App. filed Sept. 10, 1894. The combination with a flexible cord having conducting and non-conducting terminal stands of a rigid terminal attachment therefor, combining in itself a fastening device for the said conducting stand and a suspension support for the said non-conducting stand, relieving the electrical conductor from all strain.

536,684. SELF-LOCKING CLEAT FOR ELECTRIC WIRING; F. O. Creager, Marseilles, Ill. App. filed Jan. 14, 1895. The combination of a cleat having a transverse wire, a recess contiguous to said wire recess, and a dog in said contiguous recess arranged loosely therein and adapted to engage and hold taut the electric wire.

536,689. ELECTRIC BATTERY; H. W. Libbey, Boston, Mass. App. filed Feb. 23 1894. The combination consisting of two outer discs or plates having inwardly projecting rims of insulating material, a central ring of insulating material, two perforated discs forming the negative elements and a central divided positive element, absorbent material on each side of said elements, and means for supplying the exciting fluid to the said absorbent material.

536,705. TELEPHONING APPARATUS; W. B. Robertson, Philadelphia, Pa. App. filed Sept. 7, 1894. The combination in a telephone of a receiver, and an alarm or indicator, with means for operating the alarm or indicator, and a controlling device thrown into operation by the weight of the receiver for putting the alarm into action, consisting of a switch device connected with the flexible conductor cord of the receiver whereby the weight of the receiver acting through the cord operates the switch device.

536,730. ELECTRICAL CONTROLLING SYSTEM FOR ELEVATORS; C. O. Mailloux, New York, N. Y. App. filed Dec. 20, 1894. The combination with the elevator and its starting mechanism of two controlling circuits, one causing the car to go up, and the other down, an automatic switch at each landing actuated by the car for closing the one or the other branch according as the car is above or below the said switch and adapted to stand in an intermediate position to break the circuit when the car is at a landing, and manual circuit closing device or devices at each landing whereby either branch may be closed at will.

536,748. DYNAMO DRIVEN FROM AXLES OF RAILWAY CARS; W. Biddle, Brooklyn, N. Y. App. filed May 31, 1894. The combination with the car axle and a dynamo of a dynamo frame extending up over the axle and having a journal box, an oil box below the axle and bolts for connecting the parts, a bearer upon which the distant end of the dynamo frame rests, and upon which it is free to move in any direction.

536,763. TELEPHONE; J. Serdinko, San Antonio, Tex. App. filed Dec. 4, 1894. The combination with the magnets of a magnetic call, the bobbin, the diaphragm fixed in front of the latter, the iron disc and core in proximity to the said magnets, the said core extending through the bobbin, into close proximity to the diaphragm, the said magnets of a magneto call having an iron extension piece on one side only and the magneto call armature.

536,764. ELECTRIC BLOCK SIGNAL; F. P. Snow, Lynn, Mass. App. filed April 27, 1894. The combination of electric railway track between two stations, a trolley wire accompanying such track, an electric signal at each station, an electric switch and switch magnet at each station, a normally open local circuit from the track through such signal and magnet to the trolley wire at each station, and a normally open circuit controlling said local circuit, which is capable of being closed at either station from the trolley wire at that station through the signal and magnet at the other station to the track at such other station, and also with car-operating circuit-controlling mechanism at each station.

536,766. TYPEWRITING MACHINE ATTACHMENT; C. Spiro, New York, N. Y. App. filed Oct. 15, 1894. The combination of a key lever, a universal bail, a rotatable shaft, interposed gearing, a ratchet wheel fast on the shaft and carrying a pin, means movable independent of the shaft for rotating said ratchet wheel in one direction, and a vertically movable arm having a cam-portion at its lower end and a hook at its upper end.

536,787. TELEPHONE EXCHANGE SYSTEM AND APPARATUS; H. V. Hayes and T. Spencer, Cambridge, Mass. App. filed Sept. 10, 1894. The combination of a telephone circuit extending between two stations through an intermediate station and divided by interposed induction coils into a series of independent conductively continuous sections, each containing a circuit controller, a signal current generator controlled thereby, and an automatic signal indicating device.

536,792. SOCKET FOR INCANDESCENT LAMPS; F. H. Soden, Chicago, Ill. App. filed Feb. 12, 1890. A socket consisting of a shell of porcelain or like material provided with grooves about its inner periphery, a partition of insulating material fitted removably in said grooves and dividing the socket transversely, lamp contacts mounted in the partitions to which the conductors are connected at one side, cement filled in about the conductors, thus sealing one end of the socket, and means for sealing the lamp in the other end of the socket.

536,794. ELECTRIC CONTROLLER; G. Valley, Cleveland, O. App. filed Dec. 3, 1894. The combination of a roller composed of a number of annular sections provided with the proper contact pieces and adapted to interlock laterally with each other, a central shaft carrying top and bottom clamping plates, which interlock with the end sections of the drum.

536,795. SWITCH FOR STREET CAR CONTROLLERS; G. Valley, Cleveland, O. App. filed Dec. 3, 1894. The combination in a multiple switch of a disc of insulating material and means for rotating the same, curved conducting pieces embedded therein at different levels and having both ends protruding to form contact points, the diametrically opposite conducting pieces being upon the same level and having their points alternating with those of the pieces upon a different level, and the spring contacts arranged around the disc at intervals equal to those of the contact points and in series corresponding to the different levels of the projecting contact points and in position to be engaged by said points as the disc is rotated.

536,803. CONTACT FINGER FOR ELECTRIC CONTROLLERS; S. Harris, Cleveland, O. App. filed Dec. 5, 1894. A reversible contact finger for electric controllers having the contact shoe rigidly affixed to an endless spring of flat metal to the opposite side of which is rigidly affixed a reversible contact piece.

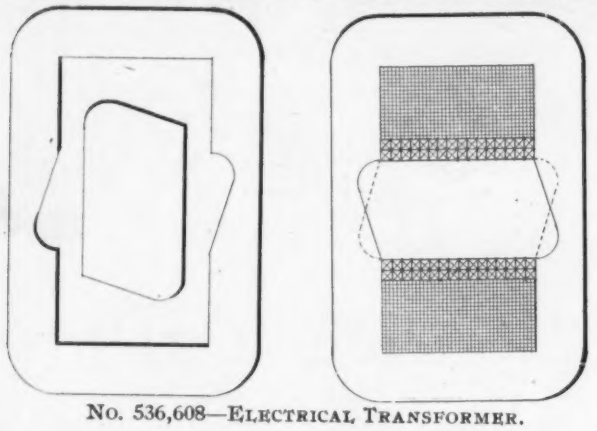
536,809. ELECTRICAL SWITCHBOARD; F. W. Jones, New York, N. Y. App. filed Jan. 22, 1895. The combination in a switchboard of parallel strips, a series of discs or buttons arranged in parallel rows between said strips, arc shaped notches in the adjacent surfaces of the strips and buttons to receive a metal pin or plug, a foundation or frame of fireproof insulating material, mica discs between said buttons and the foundation frame, and air spaces between said strips and the foundation frame, whereby insulation is increased and arcing prevented.

536,811. ELECTRIC MERCURIAL SWITCH OR CONTACT MAKER; H. Lemp, Lynn, Mass. App. filed July 26, 1888. The combination of a branching, hermetically sealed, exhausted receptacle containing separate bodies of mercury, electrodes of platinum or other non-amalgamating metal extending into said receptacle, a core of a magnet in one branch of said receptacle and having a forked end for engagement respectively with said bodies of mercury and said core, and acting thereupon to cause making or breaking of circuit between said electrodes.

536,816 COMBINED DYNAMO-ELECTRIC GENERATOR AND CURRENT DIRECTOR; J. F. McElroy, Albany, N. Y. App. filed Jan. 2, 1892. The combination of a circular range of alternate generating magnets and alternate positive and negative magnets, an outer casing magnetically connecting the magnets, a revolving armature shaft, a series of unwound armatures, one for each adjacent pair of magnets, peripherally secured upon a supporting armature core, alternating current leads from the generating magnets, a second circular range of electromagnets within the same casing and comprising resistance coils included in branches of one or both leads from the generating coils.

536,828. SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; A. C. Crehore, Ithaca, N. Y. App filed July 22, 1893. The combination of a sectional working conductor normally insulated, an auxiliary sectional conductor arranged parallel to the former, and also normally out of connection with the power line, a contact carried by the car and arranged to be always in connection with one or more of the sections of the auxiliary conductor, and switches for connecting the sections of working conductor with the supply line, and switch operating magnets each energized to close the switch by a branch of the power current passed over a section of the auxiliary conductor, as the car enters each section.

536,855. SYSTEM OF ELECTRICAL PROPULSION FOR RAILWAY CARS; L. Dion, Natick, Mass. App. filed June 14, 1894 The combination of a conduit having a cover on top capable of electrical conductivity, a main conductor of electricity and an auxiliary conductor superimposed thereon and composed of members or portions connected together by links of conducting material.



No. 536,608—Electrical Transformer.

536,857. MEANS FOR THE INSULATION OF CONDUCTORS OF ELECTRICITY; L. Dion, Natick, Mass. An insulation for electric conductors consisting of a sheath or cover of rubber and glass balls interposed between the same and the conductor.

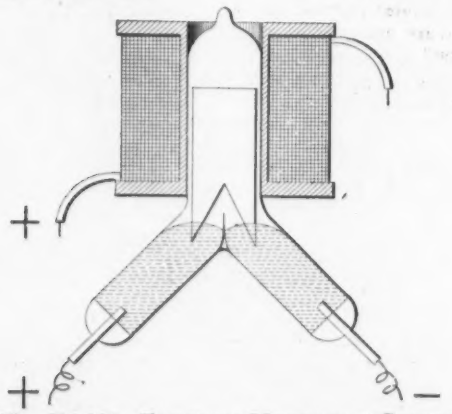
536,871. ELECTRIC DOUBLE SEMAPHORE BLOCK SIGNAL; N. O. Goldsmith, Cincinnati, O. App. filed March 24, 1894. The combination in an electric signal apparatus of an electric motor, a crank shaft operated by the motor, two signal circuits having terminals controlled by the crank shaft, and magnets and armatures in track circuits for making and breaking signal circuits at appropriate times automatically by the movements of a train.

536,872. ELECTRIC BLOCK SIGNAL; N. O. Goldsmith, Cincinnati, O. App. filed March 24, 1894. The combination in an electric signal apparatus of a series of track circuits made through the train, and duplex signal circuits in parallel connection with the same motor and provided with signal moving mechanism for operating the same signal, each signal circuit having independent terminals on the armatures of the magnets of two or more track circuits.

536,914. TELEPHONE; F. H. Brown, Chicago, Ill. App. filed Oct. 17, 1894. In a receiving telephone the combination with a suitable casing and a diaphragm, of a centrally located permanent magnet projected into the casing with its pole adjacent to the diaphragm, and a semi-circular permanent magnet arranged within the casing with its body and poles remote from the other magnet, so that the interior magnet is charged with the same polarity as the contacting pole of the other magnet.

536,915. SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; J. J. Byron, New York, N. Y. App. filed June 16, 1894. An electric railway comprising a trolley rail made up in sections insulated from each other and a contact between the sections, a main line wire, a switch consisting of a tilting armature and a contact arm, with magnets arranged at opposite ends of the switch armature, connections between contact of the trolley rail and two magnets of the next switch behind, and the return and connections between the main line, switch arm and next trolley rail section ahead.

536,918. CLOSED CONDUIT SYSTEM FOR ELECTRIC RAILWAYS; E. D. Chaplin and L. Dion, Natick, Mass. App. filed June 14, 1894. The combination of a conduit, or subway, entirely closed at all points, a main conductor or feeder arranged therein, and an auxiliary conductor consisting of a series of strips having conductivity and susceptible to magnetic attraction, their ends being overlapped and connected by a slot in one and a tongue and cross-head on the other.



No. 536,811—Electric Mercurial Switch.

536,920. TELEPHONE SYSTEM; F. R. Colvin, New York, N. Y. App. filed Dec 20, 1894. A telephone system comprising a plurality of subscriber's circuits leading to a common station, a call-receiving instrument in each subscriber's circuit, a direct current transmitter and telephone receiver adapted to be cut in at each subscriber's station, connectors at the common station for coupling two subscribers' circuits in series relation to each other, and a source of continuous current between the connectors for charging the transmitters.

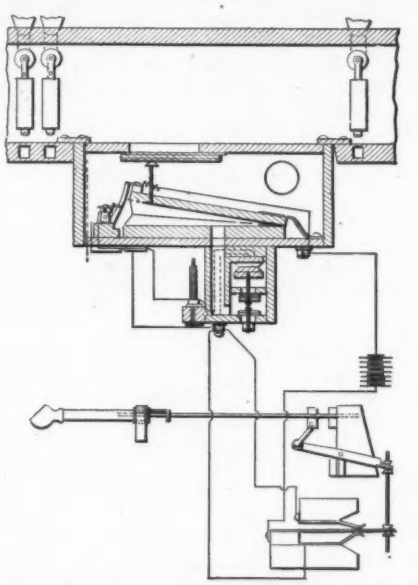
536,928. SAFETY DEVICE FOR ELECTRIC RAILWAYS HAVING SECTIONAL CONDUCTORS; L. Dion, Natick, Mass. App. filed June 14 1894. The combination with a car taking current from a series of contact plates, electrically operated signals arranged at both ends of the car, a centrally supported bar, and devices mounted upon the ends, and electrically connected to the signals.

536,926. ELECTRIC CLOCK WINDING MECHANISM; M. V. B. Ethridge and J. H. Eastman, Boston, Mass. App. filed April 28, 1894. A circuit controller composed of an exhaust tube of insulating material, with circuit wires projecting into the tube and normally separated from each other, and a gravity circuit closing and breaking device, such as a body of mercury located in the tube, adapted to electrically connect the wires.

536,952. CONDUIT ELECTRIC RAILWAY; T. C. Hughes and A W. Adams, St Louis, Mo. App. filed Feb. 12, 1894. An electric railway system with the combination of a bare working or trolley conductor made in sections and normally held out of circuit with the supply conductors by the weight of the working conductor, also a switch for making electrical connection between the working and supply conductors, operated by means of gravity or of a spring independent of the lifting power of the trolley, which becomes operative by the raising of the working conductor.

536,963. DYNAMO-ELECTRIC MACHINE; J. F. McElroy, Albany, N. Y. App. filed July 24, 1894. The combination of two field magnets arranged with unlike poles opposite each other in an armature revolving in the magnetic field between two magnets and an armature shaft passing through the fields and journaled in bearings outside of the magnets.

536,967. TROLLEY SUPPORT FOR ELECTRIC RAILWAY CARS; E. B. W. Reichel, Charlottenburg, Germany. App. filed Oct. 25, 1894. A support for a contact device for an electric car comprising an arm swinging on a vertically swinging frame, a spring resisting the pivotal movement of the arm from the vertical, and a spring resisting the downward movement of the frame.



No. 536,978—Electro-Pneumatic Stop Action for Pipe Organs.

536,973. BRUSH HOLDER FOR DYNAMO-ELECTRIC MACHINES AND MOTORS; G. Valley, Cleveland, O. App. filed Dec. 15, 1894 The combination of a brush holder having a spring-actuated brush-feeder and a recessed wing piece, an insulating yoke having slotted end fitting the recess of the wing piece, and a bolt rigidly but adjustably securing the holder upon the yoke.

536,974. ELECTRIC ORGAN COUPLING MECHANISM; E. S. Votey, Detroit, Mich. App. filed April 7, 1894. A coupler provided with contact bars, one with the main electrical conductor, and the other with an independent electrical conductor, an independent key actuated spring bar for each of the contact bars to simultaneously open and close electrical connection through each of said contact bars, and a switch to open and close electrical connection.

536,975. ELECTRICALLY CONTROLLED MAGNET AND VALVE FOR PIPE ORGANS; E. S. Votey and W. D. Wood, Detroit, Mich. App. filed April 7, 1894. An electrical magnet having a metal base provided with communicating inlet and exhaust orifices, a core and its windings, a perforated plate uniting the terminals of the core with the inlet orifices, an armature operated by the core and its windings to control the communication, and a thimble uniting the core and its windings with the base.

536,977. ELECTROMAGNET FOR PIPE ORGANS; E. S. Votey, W. B. Fleming and W. D. Wood, Detroit, Mich. App. filed April 7, 1894. An electrical magnet provided with a metal cup or base having channels communicating with one another and opening through the cup upon the same side, an armature located within the cup to control the communication of the channels, a magnet core and its windings to attract the armature, and a cup having a threaded engagement upon the base to support the core and its windings.

536,978. ELECTROPNEUMATIC STOP ACTION FOR PIPE ORGANS; E. S. Votey, W. B. Fleming and W. D. Wood, Detroit, Mich. App. filed April 16, 1894. The combination in an organ of an electrical magnet constructed with a metal cup provided with communicable channels, an armature to control the communication, and air passages communicating with the first named channels.